LOCAL INCENTIVES FOR HIGH TECHNOLOGY FIRMS AND INNOVATION

HEARING

BEFORE THE

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SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

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[1] On assignment to Budget Committee for 97th Congress.

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Subcommittee on Science, Research and Technology

at a hearing on

"Local Incentives for High-Technology Firms and Innovation"

Columbus, Ohio

February 16, 1982

VI

Dr. Arthur Adams
Vice Provost
Ohio State University

Adams stressed the importance of the university-business link in making Columbus, Ohio a center for productive high technology industry. He explained the role universities played in the creation of successful high technology firms in Massachusetts and California. Adams felt that Ohio State University could serve a similar function for Columbus businessmen. He listed the University's assets, including $86 million in research funding, education of professionals for high technology fields and spin-off of high technology companies. Despite these advantages, however, Adams noted that Columbus had not achieved a high level of productivity.

He attributed this to the hesitancy of Columbus entrepreneurs. Adams felt that complacency and uncertainty about the economy were limiting cooperation between Columbus industrialists and the University. He described the University's efforts to provide accessibility, such as sponsorship of conferences and participation in the Columbus Chamber of Commerce High Technology Task Force. Adams emphasized, however, the dependent nature of the University's participation in the local economy. He said Columbus businessmen had to take the initiative in utilizing the University's resources. Adams challenged them to define their needs so the University could offer the greatest assistance.

Adams briefly outlined other factors which would stimulate productivity growth in Columbus. Among these were requests for expansion of NSF seed money programs and new tax policies to encourage companies to donate expensive equipment to universities. He also mentioned further development of urban extension programs and the need for swifter allocation of venture capital. His primary concern remained, however, improvement of the connection between Ohio State University and Columbus high technology companies.

VII

Dr. Donald Glower, Dean
College of Engineering
Ohio State University

Glower concentrated on the need for adequate engineering education to maintain the availability of technology resources in the U.S. He supported government funding for basic and generic research and did not feel the private sector could meet this obligation. He did think, however, that more money needed to be designated for engineering. Glower claimed that more emphasis in this area would result in significant productivity and GNP gains.

Glower was concerned that numerous technological developments are lost yearly because engineering faculty and universities are not equipped to exploit discoveries. Most professors, in Glower's opinion, are forced to choose between dropping an idea or creating a new business to market it. He advocated the creation of a National Engineering Faculty Entrepreneurship Institute.

This Institute would allow professors to remain within their universities while developing their new technologies. If successful, the university would be compensated. If unsuccessful, the professor could resume normal faculty obligations. Glower estimated that the program would cost $17 million and that 2% of U.S. engineering teachers would be interested at any time. He felt that one or two important product innovations per year would meet the costs of the Institute.

In addition to simplifying the entrepreneurship aspects, the NEFEI would provide general access to teacher-student discoveries. Glower found this to be an important result of his proposed program. He also suggested more government funds to up-date lab equipment and greater incentives for infant small businesses. Glower felt that money invested in engineering education was an inexpensive way to improve GNP and productivity growth.

VIII

Mr. George B. Foster, Board Chairman, Autech Corporation
Board Chairman and CEO, Foster AirData Systems, Incorporated

Foster termed "reverse colonialism" the idea that Ohio can reduce unemployment and the stagnation of industrial growth by walking away from the manufacturing base and concentrating on communications, service industries, and microchip manufacturers, or by importing foreign firms like Honda into the state. Instead, Ohio should build on its past and make use of present resources to ignite a regional industrial revolution.

In presenting Ohio's history of technology innovation and development Foster said Ohio is not deficient in technology, entrepreneurs or capital, but in the "infrastructure of communications that link these factors elsewhere" and in the "public perception of Ohio as a good place to start or grow a technology enterprise".

For growth renewal, Ohio must look to today's emerging technologies for development of new products and new manufacturing methods.

For Ohio to turn its back on its manufacturing background would be like "throwing out the baby with the bath water". Foster's plan is a massive retrofit and upgrading of existing manufacturing operations through means including computer applications, measurement technologies, automatic controls, and digital process supervision.

Foster did state that the "environment for investment and innovation is better than it has been". The 1981 tax laws reversed bad 1976 laws that cancelled stock options and raised capital gains tax rates.

On the "public perception of Ohio" front, things are not so good. People still perceive Ohio as hogs and a few steel mills rather than as a high technology resource.

In summarizing, Foster said that Ohio "has not kept its rates of innovation up to the needs of the marketplace" and the solution is improved communication between the doers and the investors.

In response to a question, Foster said he originally started up in Ohio to take advantage of Ohio State University's physics and engineering expertise and because 80% of his market potential was within 515 miles of Columbus.

IX

Mr. John T. Heibel, President
ID Systems

Mr. Heibel's company builds color and graphics computer terminals in Columbus, Ohio. He focused not on the development of technology but the economic factors that result after it is developed. Today, over 200 U.S. companies participate in the manufacture, development, sale and thus, the creation of jobs in the production of terminals. Ohio is well represented among these firms and less than one-fourth are on the Fortune 500 list.

Today, an American display terminal is likely to have a TV device from Taiwan, integrated circuits from Singapore, memories from Japan, and printed circuit boards from Korea. Color technology today is led from incentives provided to companies in Japan.

The dominant position of Japan is due to factors which resulted from the local support of high-tech industries. We are being beaten today not in the development of the new technology but in the "industrial exploitation and continued productivity" of our industries.

What should we do about it, Heibel asked. The answers he proposed are: 1) develop national objectives for symbiotic growth in related technologies; 2) maintain our educational and research leadership; 3) make facilities available. Programs in Japan, Taiwan and Ireland are well known. Less well known are the local programs that result in the residency of high-tech companies in Bolnas, Sweden.

In Bolnas, they provide the following: facilities at cost, educational programs, R&D tax incentives, utilities expense deferral, R&D support from local universities, working capital programs from local banks insured via SBA-like programs, salary tax incentives for locals in local companies, and financing for production equipment of local manufacture.

Specific benefits of local and national support include: enhanced evolution of technology, continued market for local workers, symbiosis of corporate growth, continued financial health of communities and states, long-term national position, and local recognition as a center of technical excellence.

Responding to a question, Mr. Heibel said Columbus was chosen to start his business because of low rental and labor costs compared to Silicon Valley or Route 128 in Massachusetts.

Mr. Charles G. James
President, Scientific Advances, Inc.

Mr. James' firm's mission is the support of small, technically innovative companies. Assistance is provided in finding key personnel, in planning, and sometimes in technical work. They are equity investors, not lenders, and their goal is to realize capital gains over a 5-7 year period. Recently, they formed a limited partnership to gain financial strength with, among others, four Columbus insurance companies. His company is unique in the venture capital industry because of the Battelle link and geographical position.

On the national level, Mr. James said, the venture capital industry is booming today, and there is a corresponding increase in the number of entrepreneurs. What are the reasons for this boom? Revisions in the IRS Code and the Securities Law, and progress by numerous committees in dealing with patents, unnecessary regulations, and product liability insurance.

On the local level, in California, it was the early involvement of Stanford with semiconductors that led to the explosive electronics industry, and the aerospace industry contributed by creating an inflow of engineers. In Boston, it was MIT and the others and particularly their attitudes toward faculty involvement with small companies, and also the ability of existing machine tool companies to adapt to the advanced technologies as textiles declined. In both places, financial institutions had progressive approaches to risk capital lending.

But the single most important element is the "so-called quality of life. . . school systems, parks systems, the entertainment sector", etc. Cities like Columbus with excellent living conditions are prime expansion sites, and "Once this expansion/formation process begins, it feeds on itself" since people break away and start other small companies.

If there is a shortage, it isn't in technology, it's in qualified entrepreneurial businessmen.

For the local level, James presented three suggestions.

1. Consider a statewide small business investment company. The State or some mayors might catalyze this, and private capital could come from financial institutions headquartered there.
2. The university system could develop a series of entrepreneurial offices to function as advisors, and perhaps to screen ideas. They could be self-supporting.
3. The development of specialized industrial parks, not research parks, where, for example, incentives are provided to attract high tech companies.

In his summary, Mr. James said, "The entrepreneur is a free spirit who doesn't respond well to a forced or structured environment".

In response to a question, he applauded 1978 changes in capital gains laws, the White House Conference on Small Business, and stock option reinstatements.

XI

Mr. James A. Moore, Jr.
Partner in Charge of Tax Services
Coopers and Lybrand, Columbus

Mr. Moore said that since the vast majority of Coopers and Lybrand's clients are small entrepreneurial-minded businesses, they have pioneered the use of R&D partnership vehicles to raise high risk capital, and have worked closely with banks, the SBA, SBIC's, and various private capital sources. Coopers and Lybrand provides advice on business forms (corporations, partnerships, etc.), levels of capitalization, sources of equity, debt financing, franchise and marketing arrangements, tax and accounting methods, etc.

A strong local infrastructure (roads, educational institutions, etc.) said Mr. Moore, is an incentive to the entrepreneur. Access to new technology is important, as is the local support of job training and retraining programs. The existence of technology centers, such as Battelle and Ohio State in Columbus, is important since the transfer of technical knowledge to risk-taking entrepreneurs, whether it be in personnel or licenses, is a valuable factor in choosing where to locate. Mr. Moore said it is critical to establish better knowledge-transfer procedures.

Because of recent improvements, changes in R&D tax credits, accelerated cost recovery, capital gains tax, etc., are not warranted on the federal level at this time. What is warranted, said Moore, is a federal review of lending practices of certain banks and their interrelationships with SBA loan guarantee programs. Some banks are benefitting instead of small businesses. Reasonable limits on the rates which can be charged on Federally-guaranteed loans are needed.

Mr. Moore expressed worry that widespread disarray in the national capital market has led to tragic business failures and restricted growth levels of survivors. Credit markets find it hard to commit long-term risk capital at reasonable cost. He presented reasoning on why high interest rates radically change the traditional mix between short- and long-term debt investments and equity investments.

Ohio is witnessing the "collapse" of traditional industries like steel, cars, housing, and mining brought on by rising energy and capital costs, Moore said.

He stated that monetary policy is proving to be a blunt instrument in dealing with "industrial stagflation". Other tools need to be considered. "We are witnessing a collision between stimulative fiscal policies and restrictive monetary policies which creates increased upward pressure on interest rates well beyond underlying inflation rates". He concluded that our national economy is clearly not conducive to the kind of investments necessary for high-tech company formation, and thus, local conditions are largely irrelevant.

XII

Dr. Edward W. Ungar
Director, Battelle's Columbus Division

Mr. Ungar focused on some far-reaching impacts of contract research and development organizations like Battelle. High-tech companies tend to spring up near established technology centers like universities and R&D companies, and near sources of venture capital.

Mr. Ungar explained that Battelle serves as a communication "bridge" between government and industry. Contract research enables both to receive the benefits of research.

He discussed the concept of "cooperative centers of generic technology" (COGENTS), funded and managed by government. Groups like Battelle offer similar mechanisms in the private secotr. By pooling the investments of a group of companies to study a "non-proprietary" problem, Battelle is enabled to conduct major investigations that few companies could undertake alone. He presented four examples of these group endeavors: 1) ceramic shapes by injection molding; 2) close tolerance forging technology; 3) environmental reactions on materials for electrical and electronic applications, and 4) selection of materials for hydrogen sulfide service.

He described how independent contract research organizations like Battelle are highly effective instruments for industrial implementation of government-sponsored technology. Past examples include xerography and Wooster paint brushes.

In Columbus, Mr. Ungar stated that eight new small high-tech companies were established by former Battelle people.

What attracts R&D firms to an area? His answer included the availability of professional/technical staff, proximity to support staff, quality transportation, excellent public and higher education, good housing, medical and recreational facilities, lack of crime, good worker-community attitudes, reasonable operating costs, long-term availability of power, and proximity to complementing operating units.

He applauded the Columbus Chamber of Commerce for their activities in promoting the above.

He also commended the new R&D tax credit, which, along with accelerated depreciation, should stimulate innovation.

In response to a question, Mr. Ungar agreed that there is a very serious problem in American science and engineering education.

Mr. Lynn Edward Elfner
Executive Officer, Ohio Academy of Science

Dr. Elfner took as his thesis that "to harvest the fruits of science someone has to tend the orchard". He outlined the Academy's activities with respect to this and described it as a "human capital development organization". He endorsed the thought that national economic health is increasingly determined by "invisible" investments in human capital.

He cited three desires expressed by Ohio's high technology leaders: 1) the development and retention of Ohio personnel in Ohio; 2) the bettering of Ohio's image, and 3) improved industry-university linkage.

He cited a report by Dr. Robert Premus of the Joint Economic Committee, which said, "The cost and availability of labor, scientific and professional, is the dominant factor in location choice" of high-tech firms. He disagreed with other witnesses that nearness to markets, cultural amenities, transportation, or energy costs are important factors.

Of the OAS programs, he cited as most influential the Junior Academy, which discovers and fosters science ability among high school students. OAS also sponsors symposia on industry-academia relations and promotes Ohio as a good place to live in the book, Ohio's Natural Heritage.

He had several recommendations for tending the orchard on the national level:
1) Don't fight the "new federalism". Rather, shape it to help the states.
2) Fight for science/math education programs in primary and secondary schools.
3) Rather than spending more federal dollars on education studies (which are a "sheer waste") carve out a few million dollars for local disbursement.

On the state level, he called on the Ohio Development Financing Corporation (ODFC) to continue to work with the OAS, universities and researchers to increase government/university/industry understanding. Also, ODFC, along with local Chambers of Commerce ought to assist the OAS in planning and implementing a long-range program to improve Ohio's image as a good place for high-tech people. He also advised the Ohio Education Department to appoint a full-time science education supervisor.

On the local level, he said, the Columbus Chamber of Commerce should continue its leadership in bridging communication gaps. He also suggested that universities should offer continuing education courses for science teachers in the design of student research and technical communication.

In response to a question, Dr. Elfner said that student loan programs are more essential than ever in these bad economic times. They are "venture capital in the ultimate sense".

LOCAL INCENTIVES FOR HIGH TECHNOLOGY FIRMS AND INNOVATION

TUESDAY, FEBRUARY 16, 1982

House of Representatives,
Committee on Science and Technology,
Subcommittee on Science, Research and Technology,
Columbus, Ohio.

The subcommittee met, pursuant to call, at 9:00 a.m., in the COSI Auditorium, 280 East Broad Street, Columbus, Ohio, Hon. Doug Walgren (chairman of the subcommittee), presiding.

Mr. Shamansky. I welcome you all to this subcommittee field hearing by the U.S. House Committee on Science and Technology, Subcommittee on Science Research and Technology.

Personal thanks are in order to our subcommittee chairman, Doug Walgren, of Pennsylvania, on my left; Representative Claudine Schneider of Rhode Island, on the far right, and Representative Allen Ertel of Pennsylvania.

I am also pleased to welcome our witnesses, and the committee appreciates your participation and the contributions to this hearing.

The committee has held several hearings over the past year on high technology and innovation. Under consideration have been issues such as H.R. 4564, the Uniform Federal Research and Development Utilization Act of 1981, introduced by my colleague, Allen Ertel.

The thrust of Representative Ertel's bill is to insure that under most circumstances title to inventions conceived under Federal contracts remain with the contractor.

The committee has also held hearings on the human factor, in innovation and productivity, engineering manpower concerns, and Federal assistance for small business.

In light of our concern for high technology firms and innovation, important sources of economic growth and job creation, we want to examine what role, if any, the local community, as distinct from the Federal Government, should play in enhancing the development of high technology enterprises.

It is my view that the growth of such enterprises is strongly influenced by local conditions and incentives. No matter what happens in Washington, the acceptance of high technology goods, services, and the firms offering them, depends on support from local business people, financiers, educational institutions, political leaders, and the community in general.

To an often unrecognized degree, Central Ohio has fostered and encouraged high technology firms and innovations. This should not be surprising since the Columbus area is home to the Ohio State University, Battelle Memorial Institute, Chemical Abstracts, the On-Line Computer Library Center, Banc One, CompuServe, Warner Amex Qube, and numerous other firms like AccuRay, Ashland Chemicals, Foster Air Data, ID Systems, and Advanced Robotics.

However, we cannot assume that the future will take care of itself in this vital area. Recently, we have been forced to reexamine our American economy, especially for the Midwest and the Northeast. Beset by high inflation, unemployment, deficits in our balance of trade, basic structural problems in major industries, like steel and auto, and very low rates of productivity increases, our region seems to be in trouble. Whether this proves temporary depends upon actions taken by our business leaders, attitudes of our communities with regard to consumption and investment, and the decisions of local, State, and Federal Government leaders.

Economists and developers often regard high technology firms as especially desirable for local economies because they develop and use products and techniques which may provide the basis for other new growth industries. They attract a work force that is usually college-educated and/or technically and professionally trained, active in educational, cultural, and social efforts. Most of all, they provide employment opportunities which strengthen the community at many levels, and retain and attract population and additional businesses.

Because Columbus hosts a number of such firms and institutions, I requested the subcommittee to hold a hearing here. Specific factors attract high technology activities to certain communities and nourish their development.

Advances in high technology research, development, and applications are a key to improving the economy of our region and our Nation.

So, the testimony we hear today may prove most helpful for other parts of the country as well as for ourselves.

Chairman Walgren, I appreciate your decision to hold this hearing in Columbus, as well as the participation of you, Congresswoman Schneider, and Congressman Ertel.

[Additional remarks for the record submitted by Hon. Bob Shamansky after the hearing follow:]

PREPARED STATEMENT OF HON. BOB SHAMANSKY

Increased attention has been given to the difficult conditions facing many local economies. Local governments are experimenting with a long list of economic strategies to help bring stability to their communities.

Some local governments focus their attention on small firms specializing in high technology products. Studies show that the contributions of small firms to local and national economies are overwhelming. Small research and development firms are a primary source of major innovation in the United States. Firms with less than 1,000 employees accounted for almost one-half of all major U.S. innovation during the period from 1953 to 1973.

State and local governments concentrating on promotion of high-technology and related support service firms have experienced a significant improvement. For example, the Raleigh-Durham-Chapel Hill metropolitan area of North Carolina—known as the Research Triangle—has experienced an envious employment rate. In

January the unemployment rate for the Raleigh area was 4.6 percent and Durham County's was 4.7 percent. By comparison, the statewide unemployment rate was over 9 percent.

Similar examples of the impact of high-technology firms have occurred in areas such as the "Silicon Valley," Calif.; Route 128, Massachusetts; and Silicon Prairie, Tex. This generated interest among the members of the Science and Technology Subcommittee on Science, Research and Technology to pursue the question of incentives for these firms. As a member of the subcommittee, I requested a field hearing in Columbus, Ohio to provide an opportunity to investigate a community which has begun to encourage the development and spin-off of additional scientific and high-technology firms.

Columbus, Ohio, is the home of Ohio State University, Battelle Memorial Institute, Chemical Abstracts, the On-Line Computer Library Center, Accuray, CompuServe, Bankone, Comtrac, Warner-Amex QUBE, Western Electric and many other institutions and businesses—leaders in their fields—involved with high-technology research and its application to today's problems.

Testimony given before the subcommittee substantiated the fact that the growth of high-technology firms is strongly influenced by local conditions and incentives. The acceptance of high-technology goods, services and the firms offering them depends on support from local business people, financiers, educational institutions, political leaders and the community in general. Specifically, the attraction to a community of such firms is based on elements including the quality of life, close university-industry links, labor, capital, and business climate. These elements are key to the attractiveness of a community where financial incentives, low-cost labor, and cheap land used to attract new industries.

Quality of life is clearly one of Columbus's strong attributes in attracting and maintaining high-technology entrepreneurs. Quality of life attributes include a reasonable cost of living—especially housing and taxes—recreational and cultural activities, and a good school system. Lower food, transportation, and energy costs also are part of the picture. All of these make a community a desirable place to live and work. Surprisingly few entrepreneurs calculate area financial incentives into their business location formula. Several witnesses testified to the importance of the quality of life factor.

Charles G. James, President of Scientific Advances Inc., stated that ". . . the single most important factor is the co-called quality of life . . . school systems, park systems, the entertainment sector, ..." Cities like Columbus with excellent living conditions are prime expansion sites, and once this expansion/formation process begins, it feeds on itself since people break away and start other small companies.

John Heibel, president of ID Systems described Columbus as ". . . a heck of a city. I am from San Francisco, Calif., and then Tucson, Ariz., a westerner by education, but Columbus is a tremendous place to raise a family, as is Ohio, and a lot of people have discovered that. And there's a tremendous resource of talented, educated, technically skilled people in Ohio. They don't want to leave. They would like to stay."

Universities and colleges also play a vital role in attracting high technology firms. Columbus is fortunate enough to have Ohio State University, Capital University, Otterbein College, Ohio Wesleyan University in neighboring Delaware County, Ohio Domenican College, Dension University in neighboring Licking County and other educational institutions that provide essential assistance to the business sector. Good technical schools in the area ensure a continuing supply of engineering and scientific talent as well as continuing education for those seeking retraining.

The environment of scientific awareness is supplemented by educational activities of organizations like the Ohio Academy of Science and the Center of Science and Industry (COSI). Each stimulates interest in science and technology among pre-college students and the general community. This helps augment understanding and community acceptance of high-technology businesses.

The importance of educatonal institutions is highlighted by several examples. In California the early involvement of Stanford with semi-conductors led to explosive growth in the electronics industry, and the aerospace industry contributed by creating an inflow of engineers. In Boston, it was MIT and other adjacent schools. Their attitudes toward faculty involvement with small companies, combined with the ability of existing machine tool companies to adapt to the advanced technologies as textiles declined, spurred the business boom symbolized by Route 128.

Financial resources—venture capital and seed money—obviously are an important local incentive. As stated at the hearing, Columbus may not have an abundance of venture capital compared to the Silicon Valley or Route 128, but it does have its share. Columbus has several individual investors and one of the largest venture capital firms in the Midwest—Scientific Advances, Inc. In 1981, SAI handled over 600 high-technology proposals.

The City of Columbus, Columbus Area Chamber of Commerce, Ohio State University and several individuals have taken seriously the potential for technological innovation to promote economic growth. All of them suggested and adopted measures suited to the needs of the local economy.

There is potential in Columbus to become a major competitive center for research and development, especially related to expanding communications, information, and knowledge-generating and transmitting businesses. The future application of research and development that could set Columbus apart from other communities is in the service-related activities—with the ability not only to receive televised communication, but to project it through the business and industrial community as well.

This vast potential depends on the transfer of information between research centers and industries which can make use of technological advances, according to testimony given to the subcommittee.

The Columbus Area Chamber of Commerce had previously been directing its resources into identifying those incentives that attract high-technology firms. The Chamber's Economic Development Committee has implemented a task force for specific plans and activities to develop high-technology firms in Columbus, Ohio. The task force has delineated five specific high-technology missions and appointed a group to work on each mission.

The High Technology-Education group has the mission to ensure an adequate, skilled labor supply for existing Columbus firms through cooperative efforts with local educational institutions. In addition, this group will be responsible for attracting quality skilled, technical personnel to Columbus.

The High-Technology-New Firm group has the mission to attract new high-technology firms to Columbus. It is soliciting direct input from local firms regarding the factors of location decision and what steps the Chamber and the community can take to assist in the growth of local firms.

The Distribution group mission is to attract new distribution facilities to Columbus. This group is currently developing specific information which is relevant to distribution decisions. This information will be used with the overall marketing strategy for attracting new high-technology firms.

The Headquarters and Regional Office group has developed a preliminary program designed to use direct contacts with corporate executives, inviting them to Columbus and providing them with information relative to quality of life, cost of doing business, and the availability of administrative personnel.

The Manufacturing and General Business group mission is to work with those clients who do not fall into one of the specific target categories and to develop general information regarding the Columbus economy.

Small businesses continue to be major sources of job-creation. For municipalities with the proper resources and community support, high-technology research and development can lead to the growth of new businesses, small and large, and related job creation. The expansion of high-technology firms can help rejuvenate the overall U.S. economy. Municipal conditions favorable to such enterprises locally can strengthen the economy and even the quality of life of certain localities.

Mr. SHAMANSKY. Congressman Walgren.

Mr. WALGREN. Thank you very much, Bob.

I would just like to say, very briefly, that it is a great honor to come and be in Columbus with you. I come from your sister city, Pittsburgh, so we have a great deal in common.

When we look at our economic position, both in the world and domestically, high technology or advanced technology is really the hope for our economic future. When you look at where we are succeeding internationally, it is in the higher technology areas. If you look at our balance of trade, we do very well in areas that are intensive with respect to research and development, and we do not do very well in areas that are not, especially with respect to manufactured goods.

So in terms of the position that our country will hold in the world, the key is whether we can succeed as an economy in this area.

And of course, the same thing is true with respect to our domestic economy. Where we are in trouble, the answers lie in innovation and the answers lie in moving our work force and the focus of our industries toward new technology, so what we can work out together in this area is really going to make the difference as to whether our economy, as a whole, succeeds, or whether we fall into an overall and long-term decline in the whole world scene.

The question that we're talking about: The importance of local initiatives and what the local level can provide, is most important. There is nobody, and I mean nobody, that believes that Washington has the answer to deliver from on high, or, really, has anything that it can graft on to the local community unless there is strong local support for it.

It is also true that Government is nothing more than what we do together. The real question in many ways is: Is there something we can do together in this country to improve the development of technologically advanced industries? And if there is, certainly what is there at the local level is what will make it possible.

I feel that there is much we can do together, and there's much that the Federal level has to contribute, but it can only contribute to what is already there at the local level, and it is truly what is present locally that will make anything happen. If not much is present locally, not much is going to happen, but I will be very interested in hearing from your witnesses what they feel the Federal Government has to contribute to the local level in order to make what's possible, in fact, happen.

And, then, I think also we often underestimate how available the Federal level is to local citizens. It is, I think, a way we have of demonstrating that to bring a subcommittee to Columbus and to other areas. In general, we sometimes feel overwhelmed by the size of our society when we should not.

I want to particularly express my appreciation to you as individuals for coming out and spending some time thinking about this problem together with us. I hope that you will take from your experience today the knowledge that the people involved in the Federal Government are available to you, and that they want to have an individual relationship with you.

This Government is extremely responsive to its people. The truth is that when people opt out of our system it leaves greater room and greater influence for the citizens who choose to stay in.

So, I want to express the interest of our committee in you, as individuals, and your perspectives as individuals. I think that you will not find our system of government wanting if you approach it with that in mind.

Well, thank you very much for the opportunity.

I am going to formally turn the chair over to Congressman Shamansky, and he will proceed with the order of the hearing.

Mr. **Shamansky**. Thank you, Mr. Chairman.

Congressman Ertel.

Mr. **Ertel**. Thank you very much, Congressman Shamansky.

I just want to express my thanks to you for having this hearing and for assembling such an outstanding list of witnesses. I am certainly looking forward to hearing what they have to say, especially in relation to how the Federal Government can interrelate with local communities in developing high technology.

I compliment you on having thought of bringing this hearing to Columbus. It shows your outstanding participation in our committee and also your thoughtfulness in getting these witnesses here so that we might hear them. Thank you very much for inviting me.

Mr. **Shamansky**. Thank you, Congressman Ertel.

It is a special pleasure for us to have Congresswoman Schneider here. She comes from the industrialized east with its long tradition of high technology, and I think it would be valuable to hear from her.

Mrs. **Schneider**. Thank you very much, Mr. Chairman.

I, too, share with you an appreciation for how important the high technology industry can be for State and regional economies.

As you know, much of New England has been rebuilt around a strong and growing computer and data processing industry; however, as far as I am concerned, we are far behind Columbus, and any of you that are interested in locating on the east coast, see me afterwards.

As national policy-makers and representatives of local communities, Members of Congress need to understand and encourage an economic climate suitable for the start-up and survival of high technology oriented firms.

Technological innovation is critical to the future of the United States. As a matter of fact, the Wall Street Journal predicted last year that computers and information processing will become the world's biggest business, second only to petroleum. To assure the vitality of American firms in world markets, the Government should support an environment that encourages the forces of productivity and innovation inherent in our free market.

Exactly what role is appropriate for the Federal Government is subject to an examination of the issues mixed in with some opinion. My colleagues and I have come here today as part of that examination process, and we are most grateful for the participation of all of you gathered here today.

What can the Federal Government do to promote innovation? Well, clearly, our ability to finance new programs is severly limited. However, I believe that one way that we can promote innovation in this country is to improve the rewards for risk-taking innovators. The reductions in capital gains taxes enacted by the Congress in 1978 have proved their effectiveness in stimulating innovation and technological achievement.

For example, since the 1978 cut in capital gains taxes, there have been remarkable improvements in the ability of young, high-technology firms to start up and grow. Among the highlights:

Commitments of new venture capital funds during the 18-month period between mid-1978 and the end of 1979 totaled nearly $900 million. This increase was more than twice the amount of capital committed to such funds during the seven year period, 1970 to 1977. The 12 months of 1980 generated another $900 million, and by the end of 1981, another $1.25 billion has been committed in high technology projects.

Second, investments from venture capital funds into young companies since 1978 has reached $1.2 billion per year, which is more than four times the rate of investments before the 1978 cut and significantly more of this money is now going to start-up situations.

And, third, young companies are now able to obtain needed capital from the public market far more easily than before the capital gains tax rates were decreased.

In 1980, new capital raised through initial public offerings of company stock jumped to $820 million, double the amount raised in 1979, and more than four times the average raised per year during the period 1975 to 1978. But by the end of 1981, it had doubled again to $1.76 billion.

The track record of these kinds of incentives is clear, and to the extent that State and local governments can provide similar incentives, such as research parks, economic planning with high tech firms, and a strong, long-term commitment to the educational system, technology and science-based firms will be able to compete successfully in national and international markets.

Well, I had better stop here, so that the hearing can proceed. I very much look forward to hearing from the witnesses.

Thank you, Mr. Chairman.

Mr. **SHAMANSKY**. Thank you, Congresswoman Schneider.

The format of the hearing, I think, is apparent from the schedule that we have. We will have panels of witnesses.

For all the witnesses, your prepared statements will be, without objection, made part of the record, and you are free to summarize, as the case may be. We would like to have the spoken testimony limited to ten minutes per witness, and then the custom is for the Members of the Committee to ask questions. And, so, we will divide up the day that way.

Our first panel of witnesses includes Dr. Arthur Adams, vice provost of Ohio State University, and chairman of the Governor's ad hoc research committee, and Dr. Donald Glower, dean of engineering, College of Engineering, the Ohio State University.

Welcome, gentlemen.

STATEMENTS OF ARTHUR ADAMS, VICE PROVOST, OHIO STATE UNIVERSITY AND CHAIRMAN, GOVERNOR'S AD HOC RESEARCH COMMITTEE, AND DONALD GLOWER, DEAN OF COLLEGE OF ENGINEERING, OHIO STATE UNIVERSITY

Dr. **ADAMS**. Mr. Chairman, I appreciate that very temporary promotion you gave me, but I am vice provost—one of the vice provosts at Ohio State University.

I am presently responsible for the continued education programs at Ohio State University, and in an unofficial way, I am at least partly responsible, because there are many of us responsible, for the university's cooperation with business and industry.

I have also been serving on a number of commissions and committees here in the city having to do with the economic developments of our area, and presently I am chairing a Governor's committee of college presidents, and businessmen, and State government leaders, who are trying to see how we can get better university-industry cooperation in the State.

I must say that the first two Congressmen who spoke gave a good part of my initial address, and if I may, I will simply underline that, because I think it is important to the whole point.

I know that you are aware that many of the powerful, high technology areas in this country have been spawned by the universities. "Silicon Valley" is tied in with Stanford and Berkeley. Route 128, which we are very jealous of, in Massachusetts, is closely tied in, of course, with MIT, Harvard. And the research triangle in North Carolina is a result of a moment when three of the great universities of that State decided to consolidate their research resources.

This university, Ohio State University, also works with business and industry. Last year, we performed about $10 million worth of contract research for private industry. That is out of a total of $86 million. The other $76 million mostly coming from the Federal Government.

We also provide annually about 800 serious continuing education conferences, seminars, where professional people, people in business and industry, come to learn the latest technique or the latest technology which they can take back and apply—800 sessions with about 40,000 participants.

In addition, as Congressman Shamansky pointed out, Columbus has one of the greatest research institutions in the world, Battelle Memorial Institute, and another very important institute, Chemical Abstracts.

And depending on how you classify them, according to our recent study, there is somewhere between 100 and about 700 high technology companies in the area. In other words, all the resources one would need are here, but Columbus is no "Silicon Valley", and we are wondering what could be done to improve the situation.

We have been trying very hard at the university to establish closer relations with business and industry which would speed up this development of high technology industries, but we are, at the moment, quite unsatisfied with the results.

There is a chamber of commerce high technology task force, and we are members of that; a mayor's development commission, and we are participants in that; a citizen's development commission here in the city, and our scientists and engineers at the university are ready and willing, but the kind of development a lot of us would like to see just isn't happening, and we do not really understand what the reasons are.

I sometimes think the university may be too big, may be too unfriendly looking, but Berkeley and Harvard are big.

You wonder if we suffer from town and gown xenophobia, but I think there is less of this here than in any other college and city area I have ever seen.

Perhaps the political climate is too conservative, or it may be that, again, as Congressman Shamansky said, we have been too long a fairly successful manufacturing area, or, perhaps, business is slow to recognize that the closing down of steel businesses, and rubber industries, and automobile factories, and automobile-related plants, may represent something more than just temporary results of the latest recession.

There seems to us to be an unwillingness to believe that economic conditions—basic economic conditions have altered radically, and may continue to do so. There seems to be an unwillingness to admit that we face today the fierce competition of other nations, or that we need automation badly, or that the computer really is here to stay and is going to have effects right down through the rest of our lives.

Whatever the reasons, we believe it is time to rethink, and to automate, and to encourage high technology at a great rate.

But here's our problem, we know, regardless of the role that the universities play, that we can't do this whole thing alone. If it is going to happen, enough businessmen in the area have to be convinced that they have to make it happen, and, again, I think I am underlining your point, Congressman Shamansky. The local community must act if anything is going to happen at all.

We in the university would be delighted to see some businessmen come in and say something like: "Look, we would like to sit down with you and figure out with you how to make this town boom with high technology."

We would like to have them come and say: "We want to sit with your scientists, and your scholars, and your administrators, and with you figure out what we can do."

But, quite frankly, I think we are waiting thus far in vain, and while we wait, we are wondering why people can see the problems in Massachusetts, and why they can come to solutions of the problems in North Carolina and Michigan, Pennsylvania, but not here in Columbus.

Well, what all this boils down to is that despite the community's immense resources, we have not got our ducks in a row, and unless some of the businessmen in the area help to take the bull by the horns and begin a sustained drive toward the development of high technology industry, it probably isn't going to happen here.

The university wants to help. We have the elements that are required to help, but I am saying that if local industry leaders remain passive or tied too strongly to the old ways, my feeling is that there's really little hope for progress.

I am sure you committee members have heard all this before. You have also seen some systems that work, and I hope that before this is over we can ask you some questions about better models you have seen.

Now, while all of that is true, there are some other important activities that must be carried on, and I would just like to slip through these very rapidly, if I may.

Do I have the time?

Mr. SHAMANSKY. Yes, just a couple of minutes.

Mr. ADAMS. Universities are the heart, the source, of many of the new scientific ideas that are essential to high technology development. We pour scientists, and engineers, and business people into the society, and they add millions of dollars in products and value over their lives. But to do the work properly, universities need funds for research and for the expensive scientific equipment which local subsidies cannot buy—and I am back to the Federal Government now. You really can help in a very big way here.

The research, and development, and the equipment needed to get the job done are of such vital importance, I believe, that only Congress and the Federal Government can provide the kind of support to push these measures.

At this very moment, some of our departments could not function, could not teach our students anywhere near the state of the art in science and engineering if we were not the beneficiaries of the contributions of equipment and facilities made by private industry.

I believe that you can help, and have helped already, but I hope you will continue to help by means of tax measures that encourage this kind of contribution from private industry.

Similarly—and this would be a second point—such agencies as the National Science Foundation, and there aren't many like it, are extremely valuable to the whole society and to the work that we do; for example; the research centers they have supported—the experimental centers in which NSF comes up with some front money, the university brings in its talents, several industries join as subscribers bringing up some more money to support research. We have one here, the welding engineering center. What happens, then, is that the private industries sign up for a look at the discoveries of scientists and the opportunity to license for production the discoveries the center makes.

We consider the NSF invaluable, and we would, certainly, like very much to persuade you to support its work strongly.

Here, in this State, another operation which we think is of immense interest is what is called OTTO, O-T-T-O, the [Ohio Technology Transfer Organization]. It was established by the legislature and the Board of Regents for higher education.

OTTO's headquarters are centered at Ohio State. There are a series of extension agents who are also employees at the technical schools across the State. Their business is to do in the city something like what agricultural extension has done across the countryside for many years; that is, they go directly into the small businesses with efforts to help, and they can help with problems ranging from the level of cash flow up to complex scientific advice. If they do not have the answer, they come back to Ohio State or another of the universities in this State and ask for the technical or professional help of our scholars. If they do not have it, then the central office searches the Nation for the kinds of information that is needed.

The Chancellor of our Board of Regents has been mandated to come up by next September with a full blown organization for an urban extension program based on the concepts of agriculture extension and our experience here with OTTO. Here, again, we think this is a very effective way of actually getting into the factories and having them call back to us, of applying our knowledge to their practical problems.

Thank you very much.

[The prepared statement of Dr. Adams follows:]

STATEMENT OF
ARTHUR E. ADAMS
VICE PROVOST
THE OHIO STATE UNIVERSITY
BEFORE THE
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES
FEBRUARY 16, 1982

Mr. Chairman and Members of the Subcommittee:

In your efforts to identify the crucial elements in the encouragement of high technology companies, you have undoubtedly come to recognize the important roles played by institutes of higher learning. The great centers of high technology in this country have been spawned by cooperation between universities, talented entrepreneurs, and daring investors. Examples that come immediately to mind are Silicon Valley, which began as a spin-off from Stanford University; Route 128 in Massachussets, which has profited immensely from the proximity of MIT and Harvard; and the highly successful Research Triangle of North Carolina, where three major universities decided some time ago to pool their research resources.

At The Ohio State University, our professional schools and our liberal arts colleges are and have been for many years deeply involved in working with business and industry. The University annually conducts some ten million dollars worth of research for business and industry, and many of our faculty members also act as consultants. In addition we do another $76,000,000 of research for federal and state governments. Last year we provided some eight hundred separate non-credit conferences and seminars where 40,000 professional and business people brought themselves up to date on the latest discoveries and technologies in their fields. And over the years, Ohio State has spun off numerous local high technology companies such as OCLC (Ohio College Library Center), Chemical Abstracts, Management Horizons, Industrial Date Terminals, and Industrial Data Systems.

High technology enterprises thrive in the university atmosphere for a good many reasons. First and foremost, their members profit from close relationships with our scholarly scientists, who, like themselves, work with ideas and are most excited when they are on the track of new discoveries which may have significance for mankind. In the universities the representatives of high technology companies find research help, laboratories and other scientific facilities, and graduate students eager for significant research topics and hands-on experience. Also, in the universities, colleges, and technical schools, businessmen find the highly-trained personnel -- from computer technicians and operators to engineers and scientists with advanced degrees -- they must have if their companies are to be successful.

In Columbus, along with The Ohio State University, we have one of the world's great research centers, the Battelle Memorial Institute, and another organization of world-wide scientific interest, Chemical Abstracts. We have a number of active colleges and a busy and productive technical school. We have also, depending upon how you make your classification, somewhere between one hundred and six hundred high technology companies. Despite all this, we are not in the running with Silicon Valley. The question we must ask is: What can we do to move this community up to the level of productivity we think we can and should achieve?

The present paper will avoid any effort to solve the problems of allocating venture capital and improving the political climate for growth. It will concentrate primarily upon means of improving university-industry relations in the Columbus area.

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Although our University has many on-going and fruitful relations with business, industry, and government, and although many of these are based on sound and systematic structures, we believe there is a need for much closer and more systematic relations with business and industry in the local community.

While we conduct numerous research projects for national or international concerns with headquarters on either coast or in foreign countries, for reasons hard to understand, local business people often seem hesitant to approach us and talk business with us. We have searched long and diligently for ways to improve these relations, but we remain unsatisfied with the results. Perhaps the University is forbiddingly huge and complex, hard to fathom; perhaps elements of town-and-gown xenophobia slow our communications; perhaps there is a continuing belief among our business people that universities only educate the young and that the science and engineering we teach are not really pertinent to the workplace; perhaps the local business community is over-conservative; and perhaps we have not tried hard enough: For whatever reason, we have not effectively bridged the gap and have not, therefore, achieved the systematic exchange of ideas and information required for the common effort of getting into high gear. The problem remains, and we continue to seek the means of solving it.

In recent months the community has made several efforts, all of which seem to help a little, although none help enough. The University participates in the Columbus Chamber of Commerce High Technology Task Force, which includes representatives of the other higher education institutes in the area along with businessmen, bankers, and representatives of the Chamber. We participate in the Mayor's Economic Development Council, in the Columbus Economic Development Commission, in a "Linkages" committee sponsored by business and the Ohio Board of Regents, and in the Governor's Committee on

Research. Also, as mentioned above, we provide innumerable conferences and seminars on demand, bringing the best national and international experts to Columbus to discuss with local participants the latest scientific developments and their applications.

Only recently we and the other higher education institutes in the area collaborated with the Chamber of Commerce to hold a conference attended by about one hundred heads of local high technology companies. The purpose of this conference was to identify the needs of these industries and devise better ways of working together to satisfy them. Although there have been valuable spin-offs from this conference and from the other efforts mentioned above, in fact, our efforts to build the well organized and purposeful relationships necessary to create a powerful high technology concentration here have, so far, been ineffectual.

Again the question is: Why? With the immense resources that exist here, why are we lagging in precisely the area of business activities in which so many people believe we should be leading? Undoubtedly there are many reasons, some of which go well beyond the scope of this brief paper. However, some tentative hypotheses deserve consideration here. It may be that in this state, long a manufacturing area, business is slow to realize that the closing down of steel and rubber industries and the depression in automobile and automobile-related industries may represent something more than the temporary results of the latest recession. Manufacturers appear to be hanging on, hoping to live through this recession and the next until "things get better." There seems to be little willingness to recognize that economic conditions have altered radically and may continue to do so, influenced by such widely varying causes as fierce international competition, the reorientation of our economy from manufacturing to services, the immense expansion of information industries, the need for automation, and the revolutionary impact of the computer. "Things" may "get better," but the conditions of the past will not return; it is high time to re-think, re-tool, automate, and encourage the development of high technology.

Although the University can contribute as one element in the formula for successful adaptation, and although government too can contribute significantly, it is probably the businessman himself who must take the bull by the horns and bring about the changes needed. The University must be subsidiary to the businessman who makes things happen. As an academic organization we are not focused in the same way on the hard-headed calculations of profit and loss which guide the entrepreneur and the investor. We are, however, profoundly committed to the economic revitalization of our region; we are eager to contribute where we can; and we are disappointed that more direct demands are not channelled to us.

We would like to hear businessmen say, "We are looking for ways to create an environment that would make this town boom with high technology companies. We want to sit down with your best scientists, engineers, and administrators. We want to trade ideas with them and develop systems of cooperation that work, so that we can increase the rate of economic development in this city."

Such a group of businessmen might be constituted in many ways. Indeed, there probably should be many groups. There should be, for example, a committee of the executive officers of our local high technology companies, a group which would advise us and municipal and state governments how we can all act to help. Similarly, the developers and bankers and other investment groups should be telling us how we can best contribute. We are a public university; our essential missions are research, teaching, and service. We are eager to contribute, but we feel that business must define its needs and provide the driving force for improvement.

The above paragraphs boil down to this: Despite the community's immense resources, without sustained and vigorous efforts by businessmen who are convinced that the community must take extraordinary action to move toward the development of more high technology industry, such development is probably not going to occur. If local industry leaders are passive or remain too strongly tied to the old ways of production, there is little hope for significant progress.

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A number of other activities are vital to our economic development, and must be continued while local industry, government, and the universities search for more effective ways to communicate and work together.

1. It is important that state and federal governments continue to devise ways to encourage industry to put more funds into research and development. To perform its missions to society adequately, the University needs funds to acquire and maintain the state-of-the-art scientific equipment needed for research and teaching. If we slow our basic research and development and the application of new technology, and if we work with obsolescent equipment, the community and the nation are committing economic suicide. The task of stimulating research and development and of obtaining the scientific equipment needed for leadership is so important that only congress and the federal government can achieve these ends through special tax policies and other measures.

2. We continue to need the kind of seed-money support exemplified by the National Science Foundation's Experimental Research Centers. We have one of these at Ohio State University, in welding engineering. Early-on, NSF put down a sizable amount of money, and several leading national industries subscribed in return for the right to look at discoveries made and receive licenses to market patented inventions. According to this model, over time, the government fades out while private industries expand their involvement. This system is one of the best of the available government-industry-university devices for encouraging fruitful cooperation.

3. Third, we in higher education need to expand our continuing education efforts to provide conferences and seminars at the highest levels of quality, so that business and professional people may examine local, national and international problems, new discoveries, and technological advances. Perhaps the greatest value of such conferences is that they bring together our scholars, businessmen and government officials. Sooner or later, the payoff comes when a person with an idea talks with an investor and a person who knows how to make a business move.

4. Higher education institutions in this area should expand the number of internship programs with private industry. Such programs give under-graduate and graduate students direct experience in the business or industry they have chosen for their careers. Employers get an opportunity to look students over as possible employees, and academic departments and individual businessmen develop working relationships.

5. About two years ago, the Ohio Board of Regents for Higher Education established an organization called OTTO, (The Ohio Technology Transfer Organization). Hosted at The Ohio State University, this organization has

technical extension agents at each of the technical schools in the state and in some community colleges. These agents function on the pattern of those in agricultural extension programs, except that their turf is the cities. Agents go out to small businesses to find out what help is needed and when possible provide it on the spot. When the agents or the faculty of the technical schools do not have the answers, they turn to the state's university facilities, and if the answers are not available there, the central office searches the nation.

The Board of Regents has been mandated by the state legislature to develop a full and complete Urban Extension Program for the state by September of this year. It is our hope that this system will embody the concepts of OTTO and enable the universities to contribute much more effectively than they have in the recent past.

6. Finally there is a great need for the swift allocation of venture capital to support companies that promise the development and marketing of new products. Although this is an important area, several other witnesses at this hearing will have much to say on this topic, and for the moment, we will remain silent.

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In short, Mister Chairman, the University shares the concerns of your committee. We are deeply committed to finding solutions, and hope that you will permit us to work further with you to help this community.

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Mr. **Shamansky**. Thank you very much, Dr. Adams.

Dean Glower.

Dr. **Glower**. Mr. Chairman, I am delighted to be invited here this morning.

Since you have indicated that my written testimony will be included as part of these proceedings, I will just cover some of the highlights.

First, I should say that I am Donald Glower, dean of the College of Engineering, Ohio State University.

The College of Engineering offers degrees in 21 areas, 21 disciplines, and in addition, computer science. We graduate approximately 1,000 degrees annually, and in addition, we can go through, as I go through on the written testimony, how we can demonstrate that our 300 faculty provide about $27 million a year in research efforts in total. So, you can see the magnitude of the activity that we have.

Today, I shall focus on the current role of engineering educators, their contributions, and I do this as a complement to what my colleague, Dr. Adams, has said, because I want to get to some actions which I would like to suggest to you, for a very specific action—item that you can get your hands on, so to speak, and make something happen.

My testimony is divided into a couple of areas. I give a very convincing argument as to how technology impacts the American societal context, and I go through some of the arguments, using some of our most renowned economists' data. For example, in 1980, the 25-percent slowdown in productivity, (using Kendrick's data, a shortfall of $48 billion of the $192 billion needed to remain in sixth place worldwide in per capita income), could be attributed to the reduced rate of technological progress.

And my arguments are based on that if you put some dollars into the area of technology and new innovations, and so on, that it will be very cost effective.

I point out that in 1978 we were fourth in per capita income, fifth in 1979, sixth in 1980, eighth in 1981, and it is a question of where will we be in 1982?

Dollars invested in a cost-effective manner could do much to reverse this trend.

Now, I will go to the—skip the other parts of the arguments that I have made as to the impact of the Government. Perhaps, I should just make this one statement.

In colleges of engineering across the United States, well over 90 percent of our research dollars come from the Federal Government. So it is important for you to understand in your deliberations that if you double the amount of research that we do with private industry and you cut in half the amount of research we do from the Federal Government, we are in big trouble.

The impact of engineering students following graduation is something that you should understand. In the United States we graduate about 10 percent of the work force, the engineering work force, those engineers who are doing engineering—and I am focusing this very sharply on those individuals who are involved in design, who are involved in developing new technology, and applying it toward the production of goods and services—10 percent of those are replaced annually, so that over a 10-year period the total engineering force rolls over so you can see the great impact of each graduating class from the universities.

Now, the role of the engineering educator. I would like to give a quote from Will and Ariel Durant in one of their recent books shortly before they died; "The Lessons of History." They point out that education is the transmission of civilization. Civilization is not inherited. It has to be learned and earned by each generation anew. And if this transmission should be interrupted for one century, civilization would die, and we should be savages again.

Now, the universities are the seat of where civilization is transferred, transmitted, to each succeeding generation. The transmission of the technological part of civilization is the role of the engineering educator.

Continued improvement of our civilization includes a strong dependence upon the rate and quality of our faculty, of the new technology, and its prompt application to the production of goods and services. Its transmission is the role we, at the university, have and must effectively carry out.

I would like, now, to simply point out that my arguments from here on are based on the role that the engineering faculty have of transmitting technology and new technology to the next generation; namely, our students. However, we must understand that the faculty have a second responsibility, and that is to contribute directly to our society through the development of new technology. The relative magnitude of the contribution that they make in this area depends directly upon the quality and the quantity of the educators, and upon the quality and quantity of the equipment and instrumentation in their laboratories. You have heard much about this over the last year or so.

Now, R. & D. contributions have historically been discussed before your committee and other distinguished bodies of the Congress as open literature contributions through publications and patents.

I should concentrate today on an area that has not been discussed previously with you. I speak of new technology which is generated by faculty-students teams, but which is not currently exploited. To understand this, I would like to just go through a brief life cycle of a faculty member, and I will stick to the engineering faculty since I know them better, and I won't be accused of misleading you as to how my colleagues live.

Now, the professor begins a career by being assigned to teaching students, undergraduates, primarily. This requires on the average—which might surprise many of you—a 60-hour week, because during the week the faculty member prepares lectures, gives the lectures to the student, and during the day there is one student after another coming in and out of the faculty member's office for counsel. They do not have time to prepare their lectures during the day, so they do their preparation in the evening.

Now, this goes for a while until the faculty member becomes more experienced, and, then, they start doing some sponsored research and development. In preparation for this time in their career they were doing some unsponsored research. The cycle evolves to the point where, perhaps, they would be spending 30 hours a week lecturing to students and 30 hours a week performing research.

The cycle continues until the time the professor finishes a particular research project, and they go back, get a new project, and the cycle is repeated. From time to time, now, new technology is developed, and this is the point that I'm getting to, and the cycle then changes.

In one case—and I will give you a couple of illustrations—the new technology is part of a sponsored contract. In engineering we do a lot of contracts with the Department of Defense. And in these instances, the new technology is often put into new and/or improved products, devices, and systems.

The same is true for sponsored research from private industry. More often than not, the faculty member creates significant new technology; however, it is from parts of many research projects, many programs. They will take a little piece from this one, a little piece from the next one, and it's only the faculty members who really are aware of how all this fits together as a new technology that can be developed into a new device.

Universities, however, nationwide are particularly poor at exploiting these new technology developments. Usually, they are dropped by the professor, and the professor goes on to a new project, and the cycle starts over again.

However, from time to time, we have a faculty member who persists, and, in frustration with the university system, begins to develop the new technology on his own, and I will just say "his own" since we have to date so few women in engineering.

We, now, have a situation where the faculty member is putting in a small amount of time, let's say, for example, 20 hours a week teaching and 40 hours a week developing this new technology, using the university's laboratories, and his own basement, often called a basement operation.

After a while the demands of the university and the demands of the new technology development require much more than a 60-hour week, and now the professor is in trouble, and, at this time, families often break up. Many things happen. There simply aren't enough hours in the day to do what the faculty member wants to do.

Often the faculty member will drop the whole idea, return to the classroom in the usual fashion, and the cycle starts over again.

However, some of the few, hardy, brave souls leave the university and start their own private companies.

I have been dean of OSU's College of Engineering for 5 years, and I could point to, at least, one successful establishment of a private company, small business, for each of these years, and I can point to five or six additional new technology developments that could have resulted in a new business or a new product. I'm certain there are many others that have been abandoned without my knowledge.

I could provide you with the details of the businesses spawned by OSU and located throughout the United States. In many instances and in fact in most instances, no return was made to the university for use of the laboratories and/or other facilities which facilitated the development of the business. I am certain colleagues from engineering colleges in every State of the union can give similar examples.

I submit that we have here a great resource located in every community of the United States where an engineering college is located, and I submit that the resource has not been exploited. And, now, I shall propose an action plan to do just that.

First, in my previous discussions, and in my written context in particular, I have gone through a great deal of argument on a cost-benefit analysis justification.

So, now, I am going to simply concentrate on using the life cycle of the faculty member that I described and propose the following:

My number one action recommendation is this: I propose that you establish a national program entitled "The National Engineering Faculty Entrepreneurship Institute." Perhaps, I should inject here that it's not only engineers at the university that are entrepreneurs and develop new technology so you may want to broaden this base, but since I am from engineering, I will stick to engineering.

Mr. **Shamansky**. What is the title again?

Dr. **Glower**. The National Engineering Faculty Entrepreneurship Institute.

The purpose of the program is to provide, through the institute, a salary-support base, and a home for the faculty member while previously discovered new technology is developed into a product form, proven with regard to marketability, and then established as a new business or a new product.

Based on firsthand knowledge and experience at the Ohio State University, it is a good estimate that the total number—and I am looking at the total number of engineering faculty across the United States—18,000, and looking at the numbers of persons who would be at any one time in history interested in such a proposition—I would estimate this number to be about 360, and this would be reflected in about a $17 million per year program.

Faculty members would compete within their institution for appointment to the institute. The institute is an important concept, because while they are in the institute, they will be insulated from many of the other restraints, constraints, forces, that are upon a faculty member. They can concentrate upon developing the new product, and, perhaps, the new business.

Institute dollars would support only the faculty member's salary. The university would continue to provide access to, and use of, the laboratories, as well as provide for supplies. The institute must establish acceptable patent policies, et cetera, so that should the faculty member leave to establish a new business, the university would receive fair compensation for the laboratory and facility time. The institute would receive fair compensation for Federal investment prior to spawning the new business, and similar fair compensation should be returned to the university and the institute in those instances where a new product for an existing company was developed.

I would estimate that something like 25 percent of these projects accepted by the institute would end up in a business that would shortly get to the $10 million per year area. About a fourth of them, 25 percent, would hang around $1 million per year level, and some of the others just wouldn't make it.

The second action that I propose—and you have heard about this many times—is to have some great influence on those new engineering graduates, the 10 percent of those engineers going annually to join the work force. I ask that you get them equipment, supplies, and so on, so that they will be up to date with the state of the art. You have heard these arguments before.

I think those are the important ones that I would mention.

In conclusion, I would just simply state that I have made some arguments—the arguments that an investment of this type would be cost effective in the institute and in providing state-of-the-art equipment for the faculty.

[The prepared statement of Dr. Glower follows:]

STATEMENT

BY

DR. DONALD D. GLOWER
DEAN
COLLEGE OF ENGINEERING
THE OHIO STATE UNIVERSITY

Before the

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

HEARINGS ON LOCAL CONDITIONS WHICH FOSTER
FORMATION AND GROWTH OF HIGH TECHNOLOGY FIRMS

Tuesday, February 16, 1982

Center of Science and Industry
280 East Broad Street
Columbus, Ohio

I am Dr. Donald Glower, P.E., Dean of the College of Engineering at The Ohio State University in Columbus, Ohio. The College of Engineering offers degrees in 21 engineering disciplines and in Computer Science. Approximately 1000 BS, MS and PhD degrees are granted annually in engineering at OSU. In addition to providing academic programs leading to degrees, the approximately 300 faculty combine with their students to provide an R&D effort that represents over $14 million per year of contract research and perhaps an additional $7 million per year of unsponsored R&D. Beyond this the College manages the Transportation Research Center of Ohio which has annual activity of more than $6 million. The quality of this faculty and their R&D efforts have ranked them among the top ten engineering colleges in the United States. This college and its faculty and students are quite typical of the best colleges in the country. I make this point since the arguments which follow are also valid for other quality engineering faculties across the country.

Today I shall focus on the current role of the engineering educators, their contributions currently being made to our technical society, and the areas where there are serious problems which limit the potential impact. Finally, I shall propose a program for your consideration which I feel would harness new technology and faculty entrepreneurship and turn these underutilized resources into a real force which would spawn many new businesses and new products for existing businesses.

HOW TECHNOLOGY IMPACTS THE AMERICAN SOCIETAL CONTEXT

Technology is inextricably related with the life style we will have during the remainder of the 20th century. How technology will evolve and be used will depend on government, industry, and education. Technology is at once a benefactor and a beneficiary of all societal elements. Although economists agree relatively infrequently, there seems to be general substantive agreement among them that technology has played a major role in the growth of the American economy since World War II. Further, there also seems to be general agreement that whatever economic growth America experiences in the next two decades will be directly related to the improvement in productivity (highly dependent on technology) achieved by the industrial sector. Without economic growth, Americans will not be financially capable (individually and collectively) of supporting, let alone enhancing, the standard of living we have become accustomed to. Therefore, the creative development and application of advanced technologies is imperative for America.

The beneficial impact of technological change on industrial growth is generally accepted by economists and other researchers to be substantial, although the precise magnitude and the mechanisms by which this impact occurs are still debated. An examination of the role of government to insure the availability of this important resource requires analysis of the important indicators, some of which are the rates of growth in productivity and in the quality and reliability of the goods and services produced(1). However, Frank Batton(2), president of the New York Stock Exchange, points out that the most important source of productivity growth is the application of new technology to the production of goods and services. More than half of the net productivity growth during 1948-1977 is attributed to technical advances. Some claim that technology accounts for 60% to 70% of all productivity improvements. Kurtz(3) states that GE finds that high technology industries had double the productivity of those in the low technology. Kendrick's(4) data reveal that nearly 25% of the slowdown in productivity (in the 1973-1977 time period) was due to a reduced rate of technological progress. If these observations are correct, new technology accounted for greater than $32 billion in growth of the GNP in the U.S. in 1980. Or, using the 25% slowdown in productivity noted by Kendrick, the shortfall of about 48 of the 192 billion dollars needed to remain in sixth place in worldwide per capita income could be attributed to the reduced rate of technological progress in the U.S. In per capita income we ranked fourth in the world in 1978, fifth in 1979, sixth in 1980 and eighth in 1981; we must wisely invest the necessary resources to reverse this trend.

Tassey(1) points out that discussions of the role of technology in economic growth have increasingly focused on technology's contribution to increases in productivity. One reason is high rates of inflation, i.e., productivity gains reduce the cost-push effects of inflation on the prices of inputs production. A second reason is increased competition from foreign firms, i.e., relative productivity gains between countries greatly affect shifts in relative prices and therefore competitive advantage. Third, demands for more public goods such as defense and social services result in social tensions when a stagnant economy provides essentially the same size "pie" to be divided among all members of society, hence, pressures grow in each area.

Hence, it appears quite clear that technological change has great impact on productivity gains. It is important to realize that if this fact is accepted with the additional fact that technological change has relatively long-term impacts, then waiting until productivity growth becomes stagnant and structural barriers pervasive is too late since a "quick fix" is no longer possible. Also, the time lag associated with our marketplace reaction is long relative to the rapid advances of our science and its transfer to new technology and the new and/or improved products by our foreign competition. Hence, markets may be lost forever if we depend upon the forces of the marketplace to correct our productivity problems.

The role of the U.S. government under this administration appears to be to remove any barriers that may be the cause of reduced capacity of the private sector to provide technological change in a timely manner. It has been the role of government to support major research and development efforts that exceed the resources of private industry. It is important to recognize, however, that for the last several decades the U.S. has focused its R&D efforts on advancing basic science and generic technologies. The private sector funding of basic and generic technology R&D has been inadequate and will continue to be inadequate(1). For example, a recent study showed that no U.S. machine tool builder has a significant R&D effort. This, regardless of the fact that the Machine Tool Task Force (1980) observed that only 5% of our machine tools were numerically controlled while the Japanese industry was about 20% compared on a relative basis. Also, our private sector is made up of many small firms which rely on the diffusion of technology from the universities' engineering colleges, government laboratories, and/or larger corporations such as the Generals -- Motors and Electric. A study by the National Commission on Productivity (1976) pointed to our major problem as the growing inability to exploit the "practical know-how" -- or the engineering -- once this new science is developed.

Tesar(5) provided an analysis which indicated that machinery related R&D of the government and private sector comprised only 6% of the national total while at the same time the machinery represented (in 1980) 60% to 70% of our U.S. trade. The NSF allocated 1% of its R&D budget to machine technology. Engineering represents 9% of the total federal basic research effort with the mechanical engineering component at 0.6%. The point here is that this important industry, the machine tool industry, which once was world dominant, and which is vital to our defense effort as well as to our ability to compete internationally in the age of robots, is being greatly neglected. While this is a specific example, the neglect is across the board with regard to engineering -- that professional area with the role of turning science and new science into new technology and then into new and/or improved products.

THE IMPACT OF THE ENGINEERING STUDENT FOLLOWING GRADUATION

To understand the relative impact of engineering education upon technology advancement in America it is important to realize that the faculty educate and graduate annually 10% of the engineers who are responsible for developing and applying new technology. A good estimate is that 10% of the engineering work force is rolled over each year. The total number of living individuals in the United States, in 1980, who have experienced an engineering education (a BS degree in the engineering field) is closely approximated(6) by the number of degrees granted over the last 40 years; namely, 1,320,000 individuals. Many of these engineering graduates have found their way "up" into management positions or have shifted to non-engineering careers leaving approximately 50% engaged in the real practice of engineering, applying today's technology and generating and applying new technology toward the production of goods and services. Hence, one can conclude that in 1980, with approximately 75,000 (55,000 BS, 17,000 MS and 3,000 PhD) engineering degrees awarded, the resultant engineers accepted approximately 10% of the jobs in which engineering is being done in the U.S.

These engineers were graduated by colleges/universities where the engineering faculties were understaffed due to a shortage of qualified manpower and whose laboratories housed largely antiquated equipment. A correction of this situation would be cost effective and is, in fact, critical if this country is to remain among the top ten nations with the highest standard of living (note that in the last four years we have regressed from 4th, to 5th, to 6th, to 8th in per capita income).

THE ROLE OF THE ENGINEERING EDUCATOR

Will and Ariel Durant point out in The Lessons of History that "Education is the transmission of civilization ... civilization is not inherited, it has to be learned and earned by each generation anew. If this transmission should be interrupted for one centry, civilization would die, and we should be savages again." The transmission of today's civilization requires heavy concentration upon transmitting an improving technology to each class of engineering students. The continual improvement of our civilization includes strong dependence upon the rate and quality of development of new technology and its prompt application to the production of goods and services.

The transmission of our technical civilization through the 1980's has historically been a principal responsibility of our engineering educators, the faculty of our colleges of engineering. If the ranks of engineering educators are filled with professors knowledgeable of the state of the engineering art and if the laboratories for instruction have state-of-the-art equipment and instrumentation, then civilization in this country in the 1990's will be advanced relative to our foreign competition. If the ranks of the engineering faculty are thin and if our engineering laboratories include much antiquated equipment limiting transmission to old technology, then we will have a different country as we enter the 1990's; we will find our foreign competition with control over our electronics/computer industry and the automotive industry among others. We will have lost ground economically and will be mute testimony to the truth of the adage that "proverty brutalizes."

Most Americans, mindful of the historical successes of the U.S., confidently speak of our regaining -- in time -- the lost areas of technology leadership with the consequent return of jobs and profits from the production of goods and services. However, consider the different impacts we will experience if (1) we react with vigor and do not lose the leadership, say, in computers and aircraft production; or (2) we lose the leadership position -- such as in automobile design and production -- and then have to win it back. The dollars required to retain our technology lead in the computer field are far fewer than those required to regain the lead once it is lost. In addition, we will experience a far different standard of living in the 1990's depending upon how we react today. Each year saved in this competition for technology represents many billions of dollars.

A second responsibility for engineering educators is to contribute directly through the development of new technology. The relative magnitude of the contribution which is made by these engineering educators depends directly upon the quality and quantity of the educators and upon the quality and quantity of the equipment and instrumentation in their laboratories. The relative magnitude of their contribution also depends upon the availability of dollar support for R&D and upon the availability of top quality graduate students.

The R&D contributions have historically been discussed before congressional bodies as the contributions made to the open literature through publications and patents. I shall concentrate upon a less discussed but perhaps equally important area of contribution which could be greatly expanded and which could have great impact upon our nation's productivity and upon improvements in our technology overall. I speak of the new technology which is generated by the faculty-student team which currently is not exploited.

To understand this, consider the work schedule and life cycle of an engineering professor. A professor begins an educator's career with assignments to provide lectures to students in the classroom. This requires, on the average, a 60-hour week with time spent lecturing, counseling students, preparing lectures, reading, and doing unsponsored R&D. Within a few years the professor has obtained sponsored R&D focused toward providing answers to some technical problem. Now the lecture/counseling load is reduced and the professor may be spending 30 hours per week on each. Some time is also spent performing a consulting service for private industry. Most of the R&D results are published after the sponsored project is completed and the professor moves to a new sponsored program and gathers new students, and so the cycle continues.

From time to time new technology is developed and in these instances the following cycles may result. In one case the new technology is part of the sponsored contract so the sponsor takes the new technology and fits it into the context of that particular situation. If it is Department of Defense (DOD) sponsorship the new technology may find its way into a new and/or improved system. The same is true for sponsorship from private industry. More often than not the faculty member creates significant new technology from parts of many sponsored projects and in these instances the university and the faculty member are the only ones who are aware of the new technology. Universities nationwide are particularly poor at exploiting these new technology developments and usually they are dropped as the professor goes on to a new R&D project. However, from time to time the faculty member persists and in frustration with "the university system" begins to develop the new technology on his own.

We now have a situation where the faculty member is putting in a small amount of time, say 20 hours per week, teaching and 40 hours per week developing this new technology using the university's laboratories and "his own basement." After a while the demands of the university and the demands of the new technology development require much more than a 60-hour week and the professor is in trouble. Some drop the whole idea and return to start the life cycle all over again. A few hardy brave souls leave the university and establish a private company.

I have been dean of the OSU College of Engineering for five years and I can point to at least one successful establishment of a small business which occurred for each of these years. I can also point to 5 or 6 additional new technology developments annually which could have resulted in a new product for an existing business or new business which was abandoned due to the complexity of life which was associated with the technology development program. I am certain that others have succeeded and others have been abandoned without my knowledge.

I could provide you with details of businesses spawned by OSU and located throughout the U.S. In many instances no return was made to the university for the use of the laboratories and other facilities which facilitated the development of the new business. I am certain colleagues from engineering colleges in every state of the union could do the same. I submit that we have here a great resource located in every community of the U.S. where an engineering college is located; and I submit that the resource has not been exploited and I shall propose an action to do just that.

PLAN OF ACTION

My previous discussions have described the impact of technology upon productivity, upon new product development, and the role played in international trade competition. I also discussed the role of the engineering faculty in the transmission of the technical side of our civilization and the role of the engineering student, the future generation of technologists, toward improvements in our technical society. Others have spoken before this committee over the last year describing in detail the current crisis in engineering education, a crisis centered around a shortage of qualified faculty and PhD students, and an obsolete laboratory equipment base. I shall not attempt to provide solutions for all of these problems but instead I shall concentrate upon the needs for stimulating the development of new technology and the generation of new and/or improved products. To do this I will refer to the life cycle of the faculty member in a college of engineering as was briefly described previously. From the knowledge of this life cycle, the following action is proposed to facilitate taking advantage of the great talent and assets which are already in place and to do this with minimal cost.

Action Number One

A national program should be established entitled The National Engineering Faculty Entrepreneurship Institute. The purpose of this program is to provide, through the Institute, a salary support base and a home for the faculty member, while previously discovered new technology is developed into product form, proven with regard to marketability and then established as a new business or new product.

Based upon firsthand knowledge and experience at The Ohio State University, it is a good estimate that of the total number of approximately 18,000 engineering faculty in the U.S., about 2% are, at any one time in history, in a position to take advantage of this proposed Institute. This would mean a total of 360 Institute appointments would be in effect at any one time. An estimated salary, including fringe benefits, etc. of $4,000 per month would suggest a monthly commitment of $1,440,000 or about $17 million per year.

Faculty members would compete within their institution for appointment to the Institute on their own campus. Institute dollars would support the faculty member's salary only. The university would continue to provide access to and use of the laboratories as well as provide for supplies. The Institute must establish acceptable patent policies, etc., so that should the faculty member leave to establish a new business the university would receive fair compensation for the laboratory and faculty time, and the Institute would receive fair compensation for federal investment prior to spawning the new business. Similar fair compensation should be returned to the university and Institute in those instances where a new product for an existing company is the result.

It is to be anticipated that a certain percentage of the new technology developed will result in a product which will find too small a market to be produced economically and in these cases the program concludes with a final report to this effect.

One or two successes annually will more than offset the proposed $17 million annual investment. Experience at Ohio State would suggest that about 25% of the new technology developed and applied will succeed as a viable and expanding business which would soon pass the $10 million per year mark. Another 25% will prosper and remain for some time in the $1 million per year range. Another 25% will succeed marginally and the final 25% will be abandoned for lack of success in producing a product which has a market to support it.

Action Number Two

The antiquated engineering laboratory equipment problem is serious in that it greatly impacts the productivity of the U.S. Previous arguments supported the fact that this generation of students greatly impacts the total U.S. engineering workforce since about 10% of those practicing engineering design and development are replaced annually. A very quick and effective method of bringing the relatively large segment of our private sector (those that are known as suppliers to the large corporations as well as those parts/divisions of large corporations which are also lagging behind) up to date with the state of the art of the technology of today and tomorrow is to educate our students in laboratories where the instrumentation is state of the art and where advanced R&D is under way.

During the last decade engineering colleges have been unable to obtain the needed resources to purchase new equipment. In addition, much of today's state-of-the-art laboratory instrumentation has an effective life cycle of only a few years until it is made obsolete by newer more advanced instrumentation. The result is that each year the colleges collectively fall behind by over $100 million dollars in needed teaching and research equipment. Estimates are that $1 billion could be expended to bring just the engineering colleges' laboratories up to date. This does not include the needs of the academic programs in science. This represents an investment of about 250 new dollars annually per engineering student in our colleges.

It is proposed that cost effective legislation be enacted appropriating $50 million per year, for a ten-year period, to be matched by the university with non-federal funds; hence, providing an annual equipment improvement equal to $100 million per year and $1 billion over the ten-year period of the program. The university would be required to match these dollars on a dollar-per-dollar basis. They can use university money, state money, private industry money, or any "real" dollars they have so long as they are not federal dollars and so long as they result in the actual purchase of instrumentation and/or equipment for the engineering laboratories.

Action Number Three

Mr. Chairman, and members of the Committee, there should be a third action which would provide incentive support for the start-up of a new small business. This has been discussed on many occasions before this committee of the House of Representatives and I shall not propose a special program.

Instead, I want to simply go on record that I believe strongly that there should be some positive incentive provided to get a new small business started and to support it through the first one or two years of its existence.

CONCLUSION

I end my remarks by saying that what I have proposed is cost effective and of vital importance to our national economy. A great opportunity exists to develop a new concept, The National Engineering Faculty Entrepreneurship Institute, a concept which would exploit a resource for developing new technology and for starting new businesses throughout the U.S. using the colleges of engineering as the spawning pool. The return to the U.S. economy and, in fact the U.S. government, through tax returns would soon exceed the investment. I also commented upon the need to provide some support for those who leave the National Engineering Faculty Entrepreneurship Institute to establish a new business.

The engineering colleges' problem of antiquated equipment has been previously widely discussed and there is wide agreement that this is indeed a serious problem. I have called attention to the great impact being made and the greater impact which is possible from the annual graduates of our engineering colleges. The possible impact on 10% of those performing engineering in our technical society suggests that the modernization of our educational laboratories would also be cost effective. The investment of $1 billion over a 10-year period would be returned by more than an order of magnitude in dollars saved through being more competitive in international competition. While this is difficult to predict precisely I point out that the 25% slowdown in new technology generation may be reflected in $48 billion of the $192 billion needed in GNP to have remained in 6th place in per capita income in 1981. Certainly impacting 10% of the professionals responsible for new technology growth annually will quickly contribute several billion dollars. Within the 10-year period what difference could one anticipate between providing the one billion dollars and not providing these dollars? I believe it is clear that the difference greatly exceeds the investment and we cannot afford not to make the investment.

Mr. Chairman and members of the Committee, I urge that you seriously consider the actions I suggest and that you implement them through appropriate legislation.

Thank you.

BIBLIOGRAPHY

1. Tassey, Gregory, "The Role of Government in High-Technology Industries,"to be published by ASEE.
2. Batton, Frank, "Reaching a Higher Standard of Living," The New York Stock Exchange, January, 1979.
3. Kurtz, R.D., "CAD/CAM, Productivity, and Education," to be published by ASEE.
4. Kendrick, J.W., "Understanding Productivity," The Johns Hopkins Press.
5. Tesar, D., "Mechanical Technology R&D Part I: The Tragic Need," Mechanical Engineering, February, p.33-40, 1980a.
6. Glower, D.D., "Civilization Beyond the 80's -- Is There Hope for the U.S.?" ASEE Engineering Education, Vol. 72, No.5, pp 389-393, February 1982.

Mr. **Shamansky**. Thank you, Dean Glower, and Provost Adams. Chairman Walgren.

Mr. **Walgren**. Well, thank you very much.

It certainly seems that running through the testimony is the idea that we can do something together, that we do have very specific problems, and, particularly, Dr. Adams, you focus on the importance of continuing the kinds of contact that are developed through continuing education and the like.

One thing that troubles me, in looking at the present direction we are going nationally, is it seems that the kind of supports we have had for programs that create contact are really being dropped, and that the budget cuts are very real. I think to a certain extent we think that, well, we are just cutting back a little bit, and, perhaps, eliminating some of the extras that we can do without.

Is it your experience in the university, and I am thinking particularly of the Center of Technology Transfer, in the welding area, or not so much the transfer, but the joint effort that was being made in the welding area at Ohio State, are those kinds of programs being threatened with respect to their present level of operation?

Dr. **Adams**. Well, there are so many kinds, and I have got so many research authorities of Ohio State University here that I hardly dare answer that question one way.

On the OTTO program, which is just in its third year, just beginning to spread out and find out whether it would be useful or not, we were cut this year about half of the budget. Now, I would expect that the chancellor will come on with a larger program, and we would hope to get State appropriations in the future, but right now, I would say it has been crippled.

Dr. Karl Graff up there is head of our welding center, and head of our welding engineering department—and this is robotics—and this is a very important area.

Dr. **Graff**. I am Karl Graff, chairman of welding engineering at Ohio State.

The Center for Welding Research is funded by NSF and private industry. NSF has provided $1 million over a 5-year period. Apparently, this has escaped the recent cuts in the research funding.

We have industrial members at the center, and, presently, we have 13 companies representing all the major industries in the United States, practically. They contribute $30,000 per company per year for much-needed research in welding engineering.

This is a good example of interaction between industry and the university where some up-front money from the Federal Government has gotten programs started.

Dr. **Adams**. But, Karl, doesn't NSF drop its contribution each year until industry supports the whole thing?

Dr. **Graff**. That is correct.

It's a scheduled dropoff period. The major portion of the funding coming in the first 3 years, declining in the fourth and fifth, so that after the sixth year it is, hopefully, self-supporting with industry. We think it has been a very good example.

Dr. **Adams**. It has, indeed.

If I can just follow that up one more step, Dr. Tim Donahue, who is director of our research, is here, and also, Ken Sloan, who is head of our research foundation.

Are we better off or worse off, Tim?

Dr. **Donahue**. We are certainly being impaired by the availability of research equipment. I would say that is the major problem that we are facing now.

Dr. **Adams**. Yes.

Dr. **Donahue**. We just don't have state-of-the-art equipment which our students are expected to have when they go out to work in industry.

Dr. **Adams**. If we don't have the best equipment, we don't teach people the state of the art, and that means that society is being cheated, and the society is going to go down because it has been cheated.

I would like to answer one other part of that question, if I may, Congressman.

In the point I am trying to make, the need for relationships beween business, and Government, and the universities, I think these have got to be homegrown products, and quite frankly, I don't think we need a lot of money to sit and talk with each other.

Our continuing education operation, I said earlier, runs some 800 conferences and seminars in which, well, let's say, all the heart surgeons come for a few days to learn what the latest heart surgery techniques are, and then they go away. We can hold those conferences at cost without any outside money if there are businessmen and Government people who will sit with us to help us try to find solutions. What I am looking for is the drive to find the solutions.

Mr. **Shamansky**. Thank you, Dr. Adams.

Congressman Ertel.

Mr. **Ertel**. Thank you very much, Congressman Shamansky.

I have been interested in your presentation, Dr. Glower and Dr. Adams. You indicated that the budget for the industry-university cooperative research project with your welding institute has been increased this year over last year. However, overall, the budget has been decreased by 25 percent in the last 2 years. A program, which you have already testified as very worthwhile, is slowly being phased down.

I would just like to ask Dr. Glower, you gave that very interesting quotation from Will Durant's book that we would create a century of people who eventually would take us back to being savages. I am really worried about the decade, a little shorter period of time.

Dr. **Glower**. Shorter range period toward developing savages.

Mr. **Ertel**. Yes; I think we will just be partial savages after that 10-year period.

I would just like to read to you the level of funding and ask you if you agree with it as a principle. For instance, in the entire field of science and engineering education in the United States, we started in 1981 with $33 million. That will be reduced this year to $15 million, and that will only be predoctoral fellowships. That's the only thing that they will fund.

Science education resource improvement started at $17 million in 1981 will be zero this year.

Science education research and development was $10 million in 1981 and will be zero this year.

Science education communication started at $8 million. That will also be zero this year.

What the Federal Government has really done in the science and engineering education areas at all levels, except for the predoctoral level, is zero out its efforts to increase the scientific and engineering education levels of the United States.

Are we, with such a budget, trying to move toward that era of savages, or, at least, a decade, if we continue this kind of funding commitment, or noncommitment as the case may be?

Dr. GLOWER. Well, I would certainly say yes. I am very familiar with those numbers. My colleagues from across the country have been down talking to many of your colleagues about this problem. We fought very hard, as best we could, to keep those cuts from coming into effect.

In a very simple answer to your question, I would say yes.

Mr. ERTEL. Would you suggest, then, that the U.S. Congress try to rise up, if you will, against the administration's proposals in these areas and try and fund science and engineering education?

Dr. GLOWER. I can certainly see $100 million in the science and education area, the NSF, being spent very well.

Mr. ERTEL. I would like to point out one other area, and I think this is a mutual concern in the instrumentation area. Once again, the administration's proposed budget for instrumentation, if you take inflation into account, will be reduced at all levels of research and in universities. I think it goes down about $2 million in actual terms, which under an inflationary provision, would probably be down $20 million. Have you looked at that area as well?

Dr. GLOWER. Yes, sir; I could use $20 million in instrumentation, in engineering at Ohio State, just to get my laboratories up to date. And when you reflect that nationally, you are talking about $1 billion for engineering alone, and I make that point, because that $1 billion is not the total obligation. These are the numbers of dollars that we need.

For example, on the op ed page in one of the local newspapers, the president of Columbia University wrote that in the United States, we were $750 million short for science equipment. He called attention to science equipment needs, and I want to emphasize that that is in addition to engineering. I'm talking about engineering equipment, not science equipment. Actually the science equipment area is a bigger area than engineering, so you are looking at much more than $1 billion to modernize our laboratories, if you take the total university into account.

Mr. ERTEL. I thank you very much.

I think there is room for cooperation among the industry, Government, and the universities; however, it seems to me that one of the parties that's withdrawing from that partnership is the Federal Government, to a great extent. I want to tell you that I think this committee will be working to continue the Federal role, which I think is important to continue to try and expand our technological and scientific base in this country, and if we continue our withdrawal from these fields, I think we are going to create that decade, if you will, if not century of savages.

Mr. **Shamansky**. Thank you, Congressman Ertel.

Representative Schneider.

Mrs. **Schneider**. I would also like to pick up on the education issue. I think it is important to inform the participants and the attendees that the numbers that Congressman Ertel was articulating are simply the proposed numbers of the Reagan 1983 budget. Lest you all go home instilled with fear, I think that you can have the message from one member of the minority on the Science and Technology Committee, that none of us agree with the numbers that are proposed, or I would say, in general, none of us agree with the numbers proposed in the Reagan budget. I think it is quite clear that you will see a bipartisan effort of support in the area of increased or continued education funding in the sciences and in engineering.

I think it would be difficult for us to do otherwise, given the fact that we have had the benefit of testimony in Washington clearly indicating that we are severely falling behind already.

The other point that I would like to make is that the administration has made a significant increase in the NSF budget, and to be more specific for the record, I should say that the National Science Foundation's R. & D. obligations will increase from $961 million in 1982 to $1.033 billion in 1983, an increase of $72 million above 1982. In addition, $126 million would be obligated for research facilities and major equipment in 1983, $6 million above the 1982 level. Given the fact that we are recipients to responses to budget cutting, I would say that certainly the NSF has fared rather well in this last round of budget cutting.

And as we look to the future, I think you will see the Congress developing alternative solutions in a bipartisan way.

Mr. **Ertel**. Would the gentlelady yield for a moment?

Mrs. **Schneider**. Sure, I'd be happy to yield.

Mr. **Ertel**. I just want to point out that what we are talking about was the 1982 budget, which was cut from the 1981 budget, so that in comparison to 1982 it is kind of irrelevant. We ought to go back to what we spent in 1981, because we went down very dramatically in 1982.

Mrs. **Schneider**. Let me repeat again that those figures are going to be increased in the near future.

I did want to ask a question, however, in the area of education. Gentlemen, what are you doing to encourage the participation of women and minorities in the engineering field?

Dr. **Glower**. We are working very hard. The women in engineering have increased from almost zero 10 years ago at Ohio State, to about 15 percent today, and that is double over 3 years ago.

I would anticipate that the enrollment of women in our College of Engineering will reach 30 percent in not too long a period of time. We have enough women in the program now, so that there is sort of a synergistic effect. They see one another in the classroom, and, so, now, they are not afraid to come in.

With minorities, we are having a much more difficult time. We are having success, however. And success is not measured by total numbers that would say they are in the program. Success is measured in numbers that are graduating. If you look at the numbers in the 4-year program, and the numbers that get degrees, those numbers are up by very large percentages over a few years ago; yet, the total numbers are distressingly low.

Mrs. SCHNEIDER. Well, if you recognize the fact that women and minorities make up 60 percent of the population, and less than 5 percent of the engineers, it becomes apparent that something needs to be done to encourage them. You state that there has been an increase. I wonder if you could share with us some of the specific measures that are being taken so that we can take these back to our own universities.

Dr. GLOWER. Certainly. We have an organization that helps a great deal, a society of women engineers. It helps because the women are able to get together and talk to one another, and see that there are others there, and I think that is a big thing that helps. With regard to scholarships, support, and so forth, the women do very well.

They compete very well. For example, in one of our degree-granting programs last year, the top three students grade-point wise were women. The percentage in the program of women was something like 6 or 7 percent.

So, as far as being specific, I think the most important thing you can do is put in front of those students—and I am not talking about recruiting them—I am simply saying put in front of them what the career opportunities are, and they will make some good decisions on their own.

Mrs. SCHNEIDER. Thank you.

Mr. SHAMANSKY. Thank you very much, gentlemen.

Mr. SHAMANSKY. The next panel will be Mr. George Foster, chairman, Autech Corp., and Mr. John Heibel, president, ID Systems.

George Foster, chairman of Autech Corp.

STATEMENTS OF GEORGE FOSTER, CHAIRMAN, AUTECH CORP., AND JOHN HEIBEL, PRESIDENT, ID SYSTEMS

Mr. FOSTER. Good morning.

I will give you a little of my background because there needs to be a grain of salt with which you take my testimony.

My background includes a degree in electrical engineering, and the founding of four technology-based manufacturing companies. These have been primarily in the areas of industrial computers and the applications of nuclear radiation. Later, it was in the application of lasers and process control, and, more recently, in computers for displaying and using management information with a view toward improving manufacturing productivity.

Not to leave a stone unturned, I also became involved in starting up a company in air navigation computers.

Now, all of these were started in Ohio, and their current sizes range from AccuRay at $100 million in assets, to Foster Air Data Systems, which is worth about $3 million.

I hold over 50 patents, largely in technologies related to these companies.

Now, I have done a lot of thinking, prodded by Art Adams, Congressman Shamansky, and some others, about what our problem is in the State. If I may presume that there isn't going to be any more of the old federalism, then most of my thinking is based on the idea of what we could do for ourselves here in Ohio, rather than counting on the Federal faucet.

Now, we certainly have a high level of unemployment, and I think everyone agrees that we have industrial stagnation in our State. Some are saying that we should walk away from our aging manufacturing base and concentrate our growth in the communications and information technologies and the service industries. Still others are saying that we should import more blue collar jobs by bringing Honda and other foreign manufacturers to the State.

In my view, that doesn't get the job done. In fact, this is really a type of reverse colonialism. The engineers, the technology, and also the profits remain with a foreign company. It does not build for the United States the competitive muscle needed to regain leadership in the marketplace.

I believe there is a way that we could restore and expand our leadership in manufacturing in the new technologies and we can build on our past, and make use of our present resources, people, technology and finance, and ignite a regional industrial revolution; and it very well could be a model for the 1980's in industrial development, job creation, and in the quality of living.

Now, it is very important to look at where we are coming from. Ohio has a unique history of technology, innovation, and development, and these have in the past resulted in technical manufacturing enterprises.

Edison's first laboratory was in Ohio, and the refrigerator, the vulcanized tire, the self-starter, the cash register, and even the airplane, had their industrial beginnings in Ohio.

In later times, the Xerox process was developed in Columbus and led to major business enterprises. The Xerox experience, incidentally, is a classic example of an enterprise born in Ohio and raised elsewhere. The reasons why the company moved to Rochester instead of staying in Columbus should be very carefully addressed and understood as we consider ways to develop better linkage of the opportunities in Ohio with the sources of capital in the State.

I would like to recite a little anecdote about a company that was started in Columbus and did not move out of the State. It relates to the main thrust of my remarks, which is that technology, and technology communication, is the thrust of the startup of new companies, and the growth of established companies.

There were three guys that came to Columbus in 1950 to start what is now AccuRay Corp. One of the things that we absolutely had to have in order to have a viable company was access to radioactive-emitting, radiation-emitting materials. We were just three new guys in town. We had no license to receive the material and we did not have the technology to encapsulate it in little pellets for use as radiation devices.

However, we did know about Battelle. So we went over and called on Dr. Clyde Williams, who very graciously received us, and we explained the problem. I don't think we had been in his office for more than 10 minutes when he picked up the phone to call a staffer, Don Caulkins. He said, "Caulkins, you are now the manager of the nuclear material development section." We could hear this squawking coming out of the phone. Dr. Williams said, "You and I will worry about that later, but expect to receive some material from Oak Ridge." So that was that.

Now, I am here to tell you that if he had not done this, very likely the $100 million company would not have been started in Ohio. It would have been started in Knoxville, Tenn., because of its proximity to Oak Ridge, where the technology required was available.

More recently, Ohio is called home by three of the six companies involved in the industrial applications of lasers. I have a long, detailed listing of all kinds of companies that are operating in Ohio, and which are technology leaders in the world. Just to mention one, the single crystal casting process, which has revolutionized the performance of jet engine designs, was developed by TRW in Cleveland, and, even more recently, the first national network of computer-aided engineering centers has been organized by SDRC in Cincinnati. That will provide a national network of design aids which literally triples the productivity of design engineers doing mechanical and circuit board development.

Now, Ohio is not deficient in technology, or entrepreneuers, or capital. It is deficient in the infrastructure of communications that link these factors elsewhere. It is also deficient in the public perception of Ohio as a good place to start or grow a technology enterprise. Changing this is a formidable task, but it must be done to restore our growth, and it can be done.

For renewal of our growth, we must look to today's emerging technolgies for development of new products and new manufacturing methods. This is going to involve applying the human resources, and the financial and organizational resources which are available in computer technology, new materials, new processes in metal working, forming, bending, assembly, testing, and better marketing. All of these things can be done in Ohio, at least as well as they are in Sun Belt, East Coast, or West Coast technology manufacturing centers.

Now, I would like to review what our opportunities are to do this. One of them is that we do have a very long history of manufacturing, and we ought to look on this as a major asset rather than as a liability. Turning our backs on our manufacturing background is throwing out the baby with the bath water. What is needed is a massive retrofit and upgrading of our existing manufacturing operations through computer aided manufacturing and by making use of available technologies, automatic controls, measurement, digital process supervision, computerized data displays, 100% inspection of product quality—where we have a lot to learn from Japan—and detailed records of productivity.

We could proceed from there to adapting computer-aided design devices to a new generation of production machinery and processes to produce material-efficient, energy-efficient, reliable and cost effective products which will compete at any place, in any time, in any marketplace.

These developments will come about through the same processes that made us a leader a half century ago; invention, development, application, improvement, and prospects for profit, and the resulting attraction of financing.

Now, we are deficient at this time in a vital element of the indusrial development cycle. Art Adams was posing the question: What is it that is missing? Why are we not a Silicon Valley, or a Route 128?

Well, nothing is simple, but I think that we can identify one of the problems, and one answer is outlined in a very thick tone here. It is a plan for an industrial productivity center for restoring Ohio's growth in high productivity manufacturing. I am not talking about improving the environment for administering money market funds, or for fast foods, yarn shops, or those things. Those are very necessary and important businesses, but that is not what I am talking about.

Now, things are not all bad. The environment for investment in innovation is much better than it has been. It is now apparent, to me, anyhow, that public policies pursued in past years have not only not encouraged the process of technology development and innovation, but have, in fact, stifled such activities on virtually all counts, almost as if the situation had been engineered by the KGB. For example, the 1976 tax law cancelled certain provisions of stock options for talented and productive people in startups of technology-based firms. This meant that more risk capital had to be raised to substitute cash for hopes. At the same time, the punitive capital gains rates made this doubly difficult. And to add to the woes of the small technology firm, the Financial Accounting Standard Board's Rule 2 was introduced. Many of you are familiar with my views on that.

Much has changed in the 1981 tax law. The stock options are back. Capital gains tax is lower. And I even hear rulings about some relaxation of FASB Rule 2.

I will summarize that by saying that on tax policy there has to be a brass ring for the winner, if he wins.

Now, there is a problem with the public perception of Ohio. In travels throughout the U.S., I often query a stranger, who I may find sitting next to me in an airplane, about what they think of Ohio, what picture does it conjure up? Many times they respond with: "Well, lot of hogs, and corn and some heavy steel mills up on the lake, and auto parts, and lots of Ohio State football." Never once a mention of Ohio as a resource of high technology, nor a siting of high technology manufacturing in the State.

And yet, as it has been pointed out, Ohio has been and is now a leader in some technologies, and has resources in a wide variety of these, most of which even people in the State have never heard of.

In summary, Ohio has the resources, technology, brain power, and capital, and a long history of competitive manufacturing. The problem, as I see it, is that we have not kept our rate of innovation up to the needs of the marketplace. And the solution is to introduce a new factor into the equation, improve communication between the elements needed to cause the economic reaction desired. A chemist would call it a catalyst.

When we are successful, the public perception and the fact will be that Ohio is where the action is, or to borrow a phrase from an Ohio entrepreneur, "Ain't no reason to go any place else."

[The prepared statement of Mr. Foster follows:]

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

of the

COMMITTEE ON SCIENCE AND TECHNOLOGY

February 16, 1982

HEARINGS ON LOCAL INCENTIVES FOR HIGH TECHNOLOGY FIRMS AND INNOVATIONS

Statement of George B. Foster
Board Chairman, Autech Corporation
Board Chairman & Chief Executive Officer
Foster AirData Systems, Incorporated

Mr. Chairman and members of the Committee, I appreciate this opportunity to set forth proposals for improving the environment of this State for the accelerated development of technology based enterprises.

My background includes a degree in Electrical Engineering and the founding of four technology based manufacturing companies. These range from AccuRay Corporation, involving industrial computers and applications of nuclear radiation, to Autech Corporation, which uses lasers in process control and digital computers for maximizing manufacturing productivity to Foster Air Data Systems which is pioneering new computers in air navigation. All were started in Ohio; their current size ranges from AccuRay at 100 million to Foster Air Data Systems and Autech at 3 million.

I hold over fifty patents, largely in the technologies related to these companies.

With a high level of unemployment and stagnation of industrial growth in our state, many are saying we should walk away from our aging manufacturing base and concentrate our growth to the fields of knowledge communications and service industries with a few microchip manufacturers thrown in. Others say we should import more blue collar jobs such as Honda and other foreign manufacturers. In my view, that doesn't get the job done. In fact, this is really a type of reverse colonialism. The engineers, the technology and the profits remain with the foreign company. It does not build the U.S. competitive muscle needed to regain leadership in the world market place. I believe there is a way we can restore and expand our leadership in manufacturing in the new technologies; we can build on our past, make use of our present resources in people, technology and finance and ignite a regional industrial revolution.

It will be the model for the 80's in industrial development, job creation and quality of living.

A LOOK AT OUR PAST AND OUR PRESENT OHIO

Ohio has a unique history of technology innovation and development of the resulting technical manufacturing enterprises. Edison's first laboratory was in Ohio; the refrigerator, vulcanized rubber tire, self starter, cash register and even the airplane had their industrial beginnings in Ohio. In later times the Xerox process was developed in Columbus and led to major business enterprises that have totally changed business communications.

The Xerox experience incidentally is a classic example of an enterprise born in Ohio and raised elsewhere. The reasons why the company moved to Rochester instead of staying in Columbus should be addressed in devising a method for better linkage of opportunities with the sources of capital in the State.

More recently, Ohio is home for three of the six companies in the U.S. engaged in industrial productivity applications of lasers; the world's leading company in computer analysis of structures and product design was started in Cincinnati and is now the leading company of its type. Moreover, three major computerized data services are based in Columbus, Ohio.

The first national network of Computer Aided Engineering Centers has been organized in Ohio at SDRC in Cincinnati and will provide a nationalnetwork of design aids to triple the productivity of design engineering in the development of new products.

The single crystal casting process for jet engines was developed by TRW in Cleveland and an aggressive robotics company is in its growth phase in central Ohio.

One of the two U.S. companies supplying applied radiation devices to manufacturing automation is in Ohio. A pioneer in the computerized scanning of body tissue is an Ohio company. The Ryan Storm Scope, a major improvement in detecting adverse flying weather, was developed in Ohio. The list is a long one.

Ohio is not deficient in technology, entrepreneurs or capital. It is deficient in the infrastructure of communications that link these factors elsewhere. It is also deficient in the public perception of Ohio as a good place to start or grow a technology enterprise. Changing this is a formidable task but it must be . done to restore our growth. And it can be done.

As Don Glower, Dean of Ohio State's College of Engineering has recently pointed out, in many ways our 1920-1950 industrial development was tied to the internal combustion engine. The economics of lake transportation of raw materials and rail transportation of finished products made Ohio a logical location for our growth in "foundry" manufacturing.

For renewal of our growth we must look to today's emerging technologies for development of new products and new manufacturing methods. Applying human, financial and organizational resources in computer technology, new materials, new processes in metal working, forming, bending, assembly, testing and better marketing can be done in Ohio as well as and perhaps even better than in the Sunbelt, East Coast and West Coast technology manufacturing centers.

A LOOK AT OUR OPPORTUNITIES

Ohio's long experience in manufacturing should be viewed as a major asset rather than a liability. Turning our backs on our manufacturing background is throwing out the baby with the bath-water. What is needed is a massive retrofit and upgrading of our existing manufacturing operations through computer aided manufacturing and making use of available technologies of measurement, automatic controls, digital process supervision, computerized data displays, 100% inspection of product quality and detailed records of productivity. We can proceed from there to adapting Computer Aided Design toward a new generation of production machinery and processes producing material efficient, energy efficient, reliable and cost effective products which will compete in any market place. This will come about through the same processes that made us a leader a half century ago - invention, development, application, improvement, prospects for profit and the resulting attraction of financing.

We are deficient at this time in a vital element of the industrial development cycle - communication between doers and investors. This can be remedied by addressing the problem in several ways. One method is outlined in a proposed PLAN FOR AN INDUSTRIAL PRODUCTIVITY CENTER FOR RESTORING OHIO GROWTH IN HIGH PRODUCTIVITY MANUFACTURING.

Things are not all bad. The environment for investment in innovation is much better than it has been.

It is now apparent that public policies pursued in past years have not only not encouraged the process of technology development and product innovation, but have in fact stifled such activities on virtually every and all counts, almost as if the situation had been engineered by the KGB. For example, the 1976 tax law cancelled certain provisions of stock options for talented and productive people in startups of technology based firms. This meant that more risk capital had to be raised to substitute cash for hopes. At the same time, punitive capital gains rates made this doubly difficult. And to add to the woes of the small technology firm, the Financial Accounting Standards Board's Rule 2 was introduced, requiring all costs of research and product development to be expensed as incurred. This often resulted in the balance sheet showing negative net worth, just when the new company's new product is finally ready for manufacturing, orders are in hand and it's time to hire production people and order the inventory. The technology entrepreneur is only too familiar with the traditional banker's response to a loan application under these circumstances.

Much has changed in the 1981 tax law. The stock options are back, the capital gains tax is lower and I even hear rumblings of some relaxation of FASB Rule 2.

On the "Public Perception of Ohio" front things are not so good.

In travels throughout the U.S., I often query a stranger about what they think of Ohio, what picture does it conjure up. Many times they respond with "... lots of hogs and corn, some heavy steel mills up on the lake...auto parts and Ohio State football." Never once a mention of Ohio as a resource of high technology nor citing high technology manufacturing in the State.

And yet, as has been pointed out, Ohio has been and is now a leader in some technologies and has resources in a wide variety of technologies, most of which even people in the State have never heard of.

SUMMARY

We have resources in technology, brain power, capital and a long history of competitive manufacturing. The problem as I see it, is that we have not kept our rate of innovation up to the needs of the marketplace. The solution as I see it, is to introduce a new factor into the equation - improved communication between the elements needed to cause the economic reaction desired. A chemist would call it a catalyst.

When we are successful the public perception and the fact will be that Ohio is "where the action is" - or to borrow a phrase from an Ohio Entrepreneur -

"AIN'T NO REASON TO GO ANY PLACE ELSE"

Mr. SHAMANSKY. Thank you, Mr. Foster.

Our next witness is John Heibel, President of ID Systems, and having been through his remarkable plant, I think he is an example of what we are all talking about.

Mr. Heibel.

Thank you, Mr. Chairman.

Members of the subcommittee, I appreciate the opportunity to be here today, to appear before you, and discuss issues that are, I think, very important to me, and other businessmen in Columbus.

I speak from the perspective of a small business manager involved in a high technology area. We build color and graphics computer terminals here in Columbus. Columbus is a very unlikely place to be doing that, you might admit. You think of Silicon Valley or Route 128 in Boston. Columbus is a very appropriate home for building anything.

The question and aspect of this issue that I would like to bring some degree of focus to is not so much the development of new technology, but the economic factors that result after it is developed. After all, the goal is industry, economy, jobs for people, profit for shareholders, and quality of life for a community, and that comes from these factors that all companies, high, and if you will, low, technology companies can bring about.

I would like to use my own industry and my own subpart of the industry as an example of some things that probably should not be done in the future, and to look at what one community that, unfortunately, is not in Ohio or even in the United States, is doing about changing the climate and changing the economic factors that result from the development of businesses in the community.

A little bit of historical perspective: We build a TV set that plugs into a computer, and the computer plays pictures on the screen of the TV set, and a man sits in front of a keyboard, and I think most of the people in this room, certainly, and most of the people in our community have felt the impact of computer terminals to some degree. Just a small amount of historical background.

You might ask where did that technology come from. Well, there are several major elements of a terminal. There's a TV set. That technology—the television tube technology—came from Pennsylvania, Ohio, Iowa, and Minnesota; surprisingly, not Silicon Valley, but we will get to them. RCA, Sylvania, Clinton, and Ball are names of companies well known in the manufacture of television tubes, television monitors and assemblies.

How about the circuitry that allows computers to talk with people through imagery on the screen of these TV tubes? Michigan. It was developed in Ann Arbor, Massachusetts, New Jersey, California, and most definitely, Texas.

The pictures that appear from that circuitry on those television displays use memories, large digital memories, the larger the better, the cheaper the better, the quality of the picture improving with time. California, National Semi-Conductor and InTel Signetics in California, and Texas Instruments in Texas were the primary developers.

How about the applications used with computers and in conjunction with computers and practically every aspect of economic life and, now, our homelife. It was Honeywell and Digital Equipment in Massachusetts, SEL and Data General in Florida, IBM in New York, Control Data in Minnesota, and NCR in Ohio. It is a very diffused, variegated and distributed technology, if you will, very symbiotic, pieces plugging together to accomplish a job.

Our business is building a terminal that talks to the computer and a man. This is how we got there. It happened in, if you will, the 1950's, shortly after the development of the color television and the general introduction of television into our homelife. In the evolution of the computer, the need was for a replacement for printing terminals that were slow, noisy, and generated paper. Information transfer was the challenge, and not necessarily documentation.

Today, over 200 U.S. companies participate in the manufacture, development, and sale, and, thus, the creation of jobs in the production of terminals. Every State in the United States is represented among that community. I would like to think that Ohio has its unfair share, but it doesn't. But it is certainly represented.

It is notable that less than 25 percent of that list of 200 are represented on another list—the Fortune 500 list. It is a collection of relatively small and intermediate size companies playing a strong role in the development of technology and what we would consider our own backyard of technology—microcircuits and computer technology, the very essence of high-tech today.

We could say that the terminals that we built in the 1960's and 1970's were truly from American technology, with American parts, American labor, American capital. However, in the late 1960's, substantial support for the development of this technology and the production capacity that goes with it was put in place outside of the United States.

I would like to just highlight today who I would consider to be the leaders in these technical and production-rated technology areas. TV tube and display technology, Japan, Germany, France, Sweden, Holland; circuitry development, Japan, Great Britain; memories, Japan, Germany.

George, dive in if you hear a tender note.

Production technology, Japan, Taiwan, Korea.

Today, an American display terminal built by Digital Equipment, home in Boston, is likely to have a TV device manufactured in Taiwan, integrated circuits made in Singapore, memories from Japan, printed circuit boards from Korea.

Color technology, which we are vitally interested in, is totally led from incentives provided to companies in Japan.

I would like to note in passing that the support that has been available to industrial entities outside the United States has not been limited to the large multibillion dollar, multinational organizations such as NEC, Mitsubishi. It extends to the smallest of companies; color technology, and I use as an example a small company in Kawasaki City, Japan, Ikagami (phonetic spelling), plays a dominant role in the generation of color graphics, about 55 people, what we call a garage shop. They are roughly my own size, so I can say that. Small companies also receive support.

Well, the question is: What can we do about this? What is important? I would like to highlight the issue. The issue is not the generation of the technology. Memory technology, TV tube technology, circuitry development, the elements that are in that terminal that we built, these were American technologies. We are being beaten today, not in the development of the new technology, but the industrial exploitation and continued productivity of our industries in bringing this technology to the consumers of the world, as well as to ourselves.

And I think a significant degree of attention has got to be placed on this question, for after all, the automotive technology of 4 years ago is every bit as sophisticated as the electronic technology that I speak of today. And we see industrial dominance, not necessarily technological dominance, as being the principal issue. The industries must survive to allow the climate for continued development and evolution of technology.

Well, very quickly, I think we should do several things about it. There should be national objectives for the continuation and the strengthening of industrial exploitation of technology.

I think we must continue an educational and research leadership position with Federal, local, State, and community support. People are what make this equation work, in both industrial engineering and research and development.

Facilities availability. Mr. Foster has mentioned the excellent facilities that are available in Ohio. Yes, they must be placed in a position so that they may be used.

Very quickly, Bolnas, Sweden, 200 miles north of Stockholm, is a very small community, about 15,000 people. This community provides facilities at cost, and sponsors joint educational programs of skilled assembly personnel to train the manpower base. Also supporting high-tech development are R. & D. tax incentives, utilities expense deferrals for new companies in the area, R. & D. support from local universities, working capital programs from local banks insured by SBA-like programs, salary tax incentives for local residents employed in local industries, and finance for production equipment of local manufacture. That is a rural community in northern Sweden, not unlike many geographical aspects of Cleveland.

I think we have many benefits from enhanced support for technology and technological industries. I think we need it. I think the long-term future of our company—of our country—depends on these supports. I think the city, the State, and the Federal Governments should place attention on the growth of industrial use of technology.

[The prepared statement of Mr. Heibel follows:]

STATEMENT OF
JOHN T. HEIBEL
BEFORE THE
SCIENCE AND TECHNOLOGY SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY.
HEARING ON
"LOCAL INCENTIVES FOR HIGH-TECHNOLOGY FIRMS"
FEBRUARY 16, 1982

"LOCAL INCENTIVES FOR HIGH-TECHNOLOGY FIRMS"

INTRODUCTION:

Mr. Chairman, Members of the Subcommittee, I appreciate the opportunity to appear before you and discuss "Local Incentives for High-Technology Firms" from the viewpoint of a small business manager involved in the manufacture and sale of computer peripheral equipment based in Columbus, Ohio.

ID Systems, of which I am the President, develops and markets color and graphics display equipment - an aggressively competitive marketplace which has been characterized by technology development from, historically, American industry, and recently, increasing leadership from componentry developed from technology centers outside the U.S.

From this perspective, I would like to speak to the issue of the Desirability of Local Incentives for High-Technology Firms.

Historical Perspective

In the mid 1950's, television technology from the home entertainment industry was carried into the computer industry with the development of low-cost terminals using TV-like displays replacing, to a significant degree, the information presentation functions performed by printing terminals. The research and development efforts in this area were diffused throughout the U.S.:

TV tube development:
  Pennsylvania (RCA)
  Ohio (Sylvania)
  Iowa (Clinton)
  Minnesota (Ball)

Circuitry development:
  Michigan (Ann Arbor)
  Massachusetts (various)
  New Jersey (various)
  California (various)

Memories:
  California (National, Intel, Signetics)
  Texas (Texas Instruments)

Application:

- Massachusetts (Honeywell, Digital Equipment)
- Florida (SEL, Data General)
- New York (IBM)
- Minnesota (Control Data)
- Ohio (NCR, Burroughs)

This variegated development spawned a product-related industry which reached a sales volume in CRT terminals of over $10,000,000,000 annually. Over 200 individual companies participate in development, production, and sale of CRT terminals. Every state in the U.S. is represented in this community of terminal manufacturers; less than 20% of these businesses are to be found in the FORTUNE 500 listing of industrial companies.

Terminal products of the 60's and early 70's could be said to be built from American technology, with American parts, labor, and capital. In the late 60's substantial support for technology development in this area was put in place outside the U.S.

TV tube and display technology:

- Japan
- Germany
- France
- Sweden
- Holland

Circuitry development:

- Japan
- Great Britain
- Italy

Memories:

- Japan
- Germany

Production technology:

- Japan
- Taiwan
- Korea

Today, an "American" display terminal is likely to have a TV device manufactured in Taiwan, integrated circuits made in Singapore, memories from Japan. Color technology today is lead from incentives provided to companies in Japan.

It is notable that the dominant position assumed by Japanese companies is due to factors which resulted from "local support" of the high-technology industries. This dominance has not been limited to large, country-supported companies, but also to small, high-technology companies with local support. Efforts and growth of large companies such as Sony (display technology), NEC and Hitachi (memory technology), have been paced by pure technology development: Ikegami (color display circuitry).

It is of importance, I believe, to examine the support offered to high-technology companies at a local level in this arena and evaluate the impact and benefits to both local and national economies, as well as the international leadership position.

Support for High Technology

(1) National Objectives: Technological Development and National Leadership in a given technical area evolves from symbiotic growth in related technologies. Overall evaluation is facilitated, if not demanded, by establishment of national priorities. Two examples may be cited:

U.S. microcircuit development: a direct result of the emphasis placed upon aerospace development and the space program of the 1950's.

Japanese electronics development: a direct result of national and economic focus on consumer electronics and export balance of trade in this area.

(2) Educational and research leadership: Academic programs result in trained technical manpower within given technical areas. Examples:

Aerospace Engineering: a U.S. strength, developed by local and national support of universities and research institutes. In the 1960's the U.S. lead the world in graduation of technologists and engineers in this area.

Microelectronics: Today, in Japan, Germany, France, and Holland, ten engineers graduate each year as compared with one U.S. graduate. The support for this manpower training comes from, in large part, local support of universities, be it Osaka University or Ohio State University.

(3) Facility Availability, Production Capacity and Available Trained Production Personnel: The program of tax incentives for high-technology industries in Ireland, Japan, Taiwan, are well-known. Less well-known are the local programs which result in residency of high-technology companies in communities such as Bolnas, Sweden. In this location, production industry can find local support which includes:

a. Facilities at "cost".
b. Joint educational programs for training of skilled assembly personnel.
c. R & D tax incentives.
d. Utilities expense deferral.
e. R & D support from local universities.
f. Working capital programs from local banks insured via "SBA-like" programs.
g. Salary tax incentives for local residents employed in local industries.
f. Finance for production equipment of local manufacture.

These programs are widespread in the international community and have directly resulted in growth of both local and national industrial and high technology strength.

Specific Benefits of Local and National Support:

1. Enhanced evolution of technology - Industrial development creates new technology and a dynamic, changing industrial base which evolves with technology. The small, "grass roots" industry in high technology has historically played a key role in evolution of technology.

2. Continued Market for Local Workers - Industries which keep pace with high technology require personnel both of a technical nature (the product of local universities) as well as assembly, business, and management personnel. Evolution of technology companies provide a continuous and growing base for employment of local people.

3. Symbiosis of Corporate Growth - High-technology companies serve as general customers for services and products of local manufacture and availability.

4. Continued Financial Health of Communities and States - Communities which have seen growth in the high-technology area have been, to a large degree, able to adapt to a changing world since the employment base is forced to respond to changes in product, manufacture, and competitive position.

5. Long-term National Position - Local support of high technology can aid in the maintenance of a National Leadership in the International Marketplace.

6. Local Recognition as Centers of Technical Excellence - Community and state support of high-technology industries can, through national recognition, attract substantial corporate involvement in the community, thus promoting, in the long-term continued community growth, improvement of the educational resource, as well as increase in cultural and civic activities within the community.

Mr. **SHAMANSKY**. Thank you, Mr. Heibel.

Mr. **HEIBEL**. Thank you.

Mr. **SHAMANSKY**. Chairman Walgren.

Mr. **WALGREN**. Thank you very much.

I guess it is obvious that every perspective has its truth. I remember when I was younger they passed around this saying entitled Desiderata, as I recall. It had something to do about how everyone had their truth.

It seems like we get stuck in our country between the pure individual entrepreneurs and what is necessary for their success. Certainly, there is a tremendous need to strike the right balances in that area. And, then, whatever it is that we must do together, this kind of national, State and local government cooperation should be encouraged.

I wanted to ask: What is it that these foreign nations are doing, in your judgment, that is the major factor in their success? I agree with your statement that we are initiating the ideas, that the actual intellectual breakthroughs are made in America, but the industrialization is being done abroad. What are the two largest factors in their success? Can I address both of you with that?

Mr. **HEIBEL**. Surely.

George.

Mr. **FOSTER**. Well, I would like to respond to that two ways.

I have not yet studied the Miti in Japan in the detail I need to understand it thoroughly, but I do know two things that they do.

One of them is that they arrive at national economic technology policy through some very simple ways. For example, they look and see what they are importing. If they find out they are importing a lot of shoes from Malaysia, Miti makes a conclusion. They say they must become better at making shoes than we are. So, they pass out the word to the government administered financial interstructure, I guess, their SBA, or whatever, and they say no more lending to shoemakers, shoe manufacturers. I mean, they are just ruthless about it. And they say what we should be doing is what they are not doing, and so they direct investment, government support, and so forth, into a new area of industrial development, like memories.

Another thing that they do would make Sherman turn over in his grave. They have industry cooperative planning conferences, and they get seven manufacturers all sitting around a table, and say, "Well, here's what we got to do, and Joe, you're going to do the ion implementation work, and Charley, you're going to do the X-ray defraction laying down of the lines," and all that.

I mean that would just drive our Congress up the wall. I am not recommending that, but I am just saying that is one of the things they do.

Now, they also do something else, which I am quite familiar with, and which is detailed in my long recommendation here which I would be pleased to read in a low monotone.

They have a highly active technology and capital interchange function. In fact, there was a hilarious story about Mr. What's-his-name—Ikugatsu. He is a renowned entrepreneur, and a very wealthy man. And he went into Miti one day and he said, "I got a big bundle here burning a hole in the floor, and I want to invest it in something, you know, good, that will make more money." And they had four guys come out of the walls with proposals, and say, "Oh, there's a company here that needs some money, and they are doing this and that," and it is a very serious enterprise.

So, I hope I am answering your question. What I think we need to do is to do some of those things; not the combination and restraint of trade, but I do believe that we can do an enormous thing in this region by forcing into being through association of a data network which works, now, in Santa Clara County, Calif. You can't walk a block without running into a venture capitalist. You know, he's got a store there that says Capital and somebody's on his lunch hour from InTel, and he is thinking of starting a new company, and here is a guy, you know, with a big bundle ready to help him.

Now, the problem. In this region, the bundles are available, believe me, but the guys with the money to invest don't know about John over here trying to get this company going to—well, he would know about him now—but at the early stage, there was nothing like that at all.

There is an ole boy network that works in Boston, and Houston, and Santa Clara, and those places, but all we have got here now are the ole boys. We don't have the network.

Mr. **Ertel**. No. 1, I would like to say to you, Mr. Foster, we have got a place for you in Pennsylvania to come and start your companies.

Mrs. **Schneider**. I was there first. [Laughter.]

Mr. **Ertel**. I am curious. You came to Columbus in 1950, I think you said.

Mr. **Foster**. Yes.

Mr. **Ertel**. And you, Mr. Heibel, you started a new company here.

Now, why did you come to Ohio to start your company?

Mr. **Foster**. Very good question, and it has, I hope, a significant answer.

Two of the partners—there were three of us—had gone to Ohio State, and we were surely starting a high technology company, the industrial application of radioactive materials for penetrating radiation, and we knew we had to have four things, at a very minimum.

One of them I just mentioned, which was the technology of the radioactive material encapsulation.

A second thing was we had to have some help in radiation physics, and Dr. Marion Pool was a very active and distinguished physicist at Ohio State. And these two guys knew both of those organizations, and knew Dr. Pool.

They also knew that they were going to have to have engineering staff, and Columbus has a very excellent College of Engineering, and, so, those are three reasons.

The fourth reason was that we computed that 86 percent of our market potential lay within 515 miles of Columbus. Actually, the center of economic gravity of the business was 6 miles west of Springfield, Ohio.

We got some help, incidentally, from the Columbus Chamber of Commerce on that.

Mr. ERTEL. I think I will be hearing about that at lunch, all day, and all the time.

I am just interested, though, how you put together this combination. Was there something that caused you to want to start a new company, and then to come to Columbus? What motivated you to start a new company? Was it tax incentive? We hear so much about tax incentives to start new companies. I kind of think that most people don't start a new company because of tax incentives. We sort of waste a lot of time on that. But there are other motivating factors that put people into business, whether they have found a good idea and think they want to take a risk on it, whether they lost a job, whether they felt that the company they were with had stifled their innovative genius.

What caused you to start out on your own?

Mr. FOSTER. Well, we could spend a lot of time talking about that. The fire that burns in the entrepreneur is very similar to an ulcer, but instead of leading to drinking milk, it leads him to start up a company. He has a burning something that drives him to do this. It is interesting that the really smart people never do that. If you look at the statistics, hardly any new companies are started by MBA's, or lawyers.

Mr. SHAMANSKY. I want you to know that you wounded me in both places.

Next, you will tell me if you have an engineering degree, and that will get me in all three places that I have education.

Mr. FOSTER. No, the MBA is too smart to do that.

Mr. HEIBEL. George, you are a tough act to follow.

Well, I also came because of Ohio State. I was a professor at Ohio State. The company I am involved in today is the second company, so, in answering your question, you might ask why did we stay, or why did we establish a high-tech manufacturing company in Columbus?

Well, Columbus is a heck of a city. I am from San Francisco, Calif., and then Tucson, Ariz., a westerner by education, but Columbus is a tremendous place to raise a family, as is Ohio, and a lot of people have discovered that. And there's a tremendous resource of talented, educated, technically skilled people in Ohio. They don't want to leave. They would like to stay.

We were able to find this talent here to develop and build terminals. George has found them in computer systems, and lasers, and avionics.

Also, Ohio is a very cost-effective place to base a business compared with the square footage costs on Route 128 or Silicon Valley, or the labor costs in those areas. We are a very desirable location, and a great place for families, which, in the long run, is of strong importance to all entrepreneurs.

I would like to come back very quickly to Congressman Walgren's question, if I might, to just plant another seed. Ten years ago, there was a national priority objective put forth in Japan to place emphasis on consumer electronics. I would like to just ask you to think about that. Five years ago, a similar priority and national emphasis from MITI, Ministry of Trade and Industry, was placed on the automotive industry.

What gives me concern is their priority today, published about a year, year and a half ago, to develop artificial intelligence, computing, and peripherals, and that gets me next.

Mr. **Shamansky**. Thank you very much.

Congresswoman Schneider.

Mrs. **Schneider**. In order to increase the productive capacities that we are talking about, what kind of balance do you really feel is necessary between the State and local initiatives? I know, for example, that California and Massachusetts have increased their education budgets in these areas. And in North Carolina, they have various tax incentives that they are implementing in order to lure science and technology based industries.

Specifically, what is Ohio doing?

Mr. **Foster**. Well, right now, I would say in terms of the intrastructure of things that have to be done, we are doing quite a lot. We have a very broad, and highly effective, technical training school program. We have 2-year schools, and so forth. We are quite familiar with the number of graduates, and they are excellent. It is an excellent program.

One of the things that we have arrived at, along with everybody else, is that opening a new mattress factory in Youngstown is not going to get the job done. We need to bring together a number of elements that we already have in the state—I've used the analogy of a chemical reaction. I really believe that. We have the money. Catalyzing better communication is the main thing that we have to do to get these technology companies growing, and being formed in Ohio. I know maybe this is a different view, but I don't think we need a big bundle of Federal money to do that. I think the money is here.

Mrs. **Schneider**. What do you see as the appropriate balance between the Federal and State role, and comment on your preference for Federal involvement and money in education, or in tax incentives?

Mr. **Foster**. All right. I am very supportive of what Don Glower and Carl Graff, and those, have said about there being a Federal commitment to the support of the technology resources and technology of our universities. I really believe in that very strongly. They need to work with modern equipment.

But with regard to building factories, or things like that, I don't personally happen to agree that that is the thing public funds should be used for. I think public funds can very, very well apply in facilitating the communication between the financial resources, in particular.

Let me comment on that. There is a paradox—Chuck James is going to testify here, and I am sure he will have something to say about this—but, first, we have very few investment capital firms, venture capital firms, in Ohio. There are four or five of them, I guess, and that is unusual and not very good.

What is even worse is that most of their investments are not made in Ohio. And I have just got to conclude that the reason for this is that the opportunities are not known to them, or calibrated, or whatever.

So, I think private capital can get that job done, and the public capital and resources should be used to support education.

Mr. HEIBEL. George, I would agree with you.

I think there is a strong national role that can be played by the Federal Government. If we take a look at the benefits, industrial benefits, and technology benefits with the emphasis, for example, on the space program, concerted focus on a national objective, again, I think that the Government can and should take a strong position in support of programs, or industrial development, and truly follow through.

Mrs. SCHNEIDER. But how do we do that? I mean, we so often look to the Federal Government for the answer. Our involvement in the space program is a good, but not easily repeated example. In light of current budgetary restraint, outside of having a dictatorship, how can we say our national priority will be for the increased opportunities for science and technological advancement?

Mr. HEIBEL. I think, certainly, through the support of education, support and availability of continuation of, say, the SBA program for federally guaranteed loans for small developing companies in that area, or, in fact, support for medium- and large-size corporations in that area, be it trade support or direct financial support.

Mr. ERTEL. Will the gentlelady yield for a moment?

Mrs. SCHNEIDER. Certainly.

Mr. ERTEL. Most of the studies I have seen on the SBA don't indicate that they have been very good at venture capital areas at all. They seemed not to have done the job there. So, maybe we better try some other instrument, if that is what you are looking for, for venture capital, as Mr. Foster has indicated.

Mr. HEIBEL. I might comment on that. Perhaps not SBA, but, perhaps, the SBIC program, a revitalized, altered program of support for venture capitalists, who will selectively make investment in new corporations.

George, you might respond to that, as well.

Mr. FOSTER. I will be the last to knock the SBA. I have been the recipient of SBA lending.

Mr. HEIBEL. So have I.

Mr. FOSTER. And if you look at the program, they are, obviously, or, I think, the lender of last resort. Their terms are not very generous, and shouldn't be. Somebody who is coming in who says, "By golly, I am going to make this business go, no matter what," they have a form for that, that no matter what. And for those that make it, they look back very kindly on the SBA. They do not use most financial procedures. They do not break legs. But they are very demanding, and, properly so, in their collateralization.

So, I am supportive of the SBA. It has helped me, and I think they have helped many small businessmen. I think there has been a problem, in that there hasn't been any focus on, let us say, technology enterprise in the same way that minority aid or lending has seen.

Mr. SHAMANSKY. Thank you very much for your testimony. Very interesting.

Our next panel will be Mr. Charles G. James. I know Chuck. He is down as Chuck James, but we, who know him well, refer to him as Charles G. at all times. He is the president of Scientific Advances, which is the venture capital arm of the Battelle Memorial Institute.

And Mr. Jim Moore, partner in the tax department of Coopers and Lybrand.

STATEMENTS OF CHARLES G. JAMES, PRESIDENT, SCIENTIFIC ADVANCES, INC. AND JAMES MOORE, PARTNER, TAX DEPARTMENT, COOPERS AND LYBRAND

Mr. JAMES. Mr. Chairman and members of the committee, thank you for inviting me to join you this morning on a subject of great interest to all of us.

I am president of Scientific Advances, Inc., which is a wholly owned subsidiary of Battelle Memorial Institute.

As most of you know, Battelle is the largest, independent contract research organization in the world. The institute employs more than 7,000 people and has four major laboratories; two in the United States and two in Europe.

Scientific Advances was organized in 1962, and although it has gone through various phases, its mission, essentially, is the support of small, technically innovative companies.

These companies may be formed within the Battelle environment, based on proprietary technology, or they may come to us from without.

In all cases, we call upon Battelle scientists or engineers to assist us in the evaluation of the technology involved.

Currently, we have an interest in two Columbus-based companies, one in Cincinnati, and there are others in the area that resulted from earlier efforts. We support these companies financially, by finding key personnel, in planning, and, sometimes technically, although we are not a vehicle for free research.

Normally, we do not manage the investee companies on a day-to-day basis. We are equity investors. We are not lenders. Our objective is the creation of capital gains, usually realized over a 5- to 7-year period.

We do not charge fees, nor are we consultants in the usual sense, although a great deal of our time is spent in providing advice to entrepreneurs.

In April of this year, we formed a limited partnership known as the Technology Group in order to give ourselves greater financial strength over the longer term. Our partners are major financial institutions, and we are pleased to say that four Columbus-based insurance companies are among them.

We do not limit our activities to Ohio, but all things being equal, we would prefer to invest in companies nearby.

Within the so-called venture capital industry, we are unique. First, because of our link to Battelle, and its technical resources, and, second, because of our geographical position.

We should also mention that we have a sister subsidiary of Battelle known as Battelle Development Corp., which is active in the licensing of patents and currently has more than 100 licenses outstanding. These patents may be based upon Battelle technology or inventions by others.

As most of you know, and some have mentioned already today, the venture capital industry is booming, and billions of dollars are available through private partnerships, small business investment companies, and from the many individuals in communities like Columbus that support promising entrepreneurs.

Most of the visible capital is located in Boston, New York, Chicago, and especially San Francisco. There is relatively little in Ohio, and south of Cleveland we are probably the largest firm in the Midwest.

There is also a corresponding increase in the number of entrepreneurs appearing. Most substantial venture capital firms are reviewing 500 to 1,000 proposals annually.

It is quite possible that the decade of the 1980's will be one of entrepreneurship, and that the heros will be the presidents of small, fast-growing, technically based companies. Clearly, it is respectable, once again, to be a businessman.

The reasons for this increased activity, I think, are clear. There have been important changes in the Internal Revenue Code and revisions in the securities law. And there are numerous committees at work dealing with the subject of patents, the removal of unnecessary regulations, and such matters as product liability insurance.

Many of the obstacles to small business formation built up over a number of years at the national level have been or are being removed. This increased activity is in spite of rampaging inflation, which remains the single most important threat to small businesses of all kinds.

Now, looking at the local scene, and assuming the essentials of an infrastructure in place, which they certainly are, what are the elements leading to advanced technology company formation? Well, right away we look for models, and that takes us to Santa Clara County, or the well-known Route 128. We have read the literature, and we have asked the questions. We have benefited from our own personal experiences with companies in those areas.

Variously, the answers are:

Stanford University, early on, was involved directly or indirectly with the semiconductor, which led to the explosive electronics industry.

In Boston, it was the presence of MIT and all the other great universities, and, particularly, the attitudes toward faculty involvement with small companies.

In California, the aerospace industry was a substantially contributing factor with the resulting inflow of engineering talent.

In New England, the single most important factor was the existence of a large machine tool industry prepared to serve the advanced technologies as the textile industry declined.

It was the attitude of financial institutions; that is, the availability of risk capital and the more progressive approaches by bank lending officers.

And, finally, the response most often heard, it was simply an accident or a series of accidents in each case.

Now, all of the above, mentioned elements may be important at a given time and place; however, I am convinced that the single most important factor is the so-called quality of life, and I think that's what John Heibel touched on.

By quality of life, we mean the school systems, the park systems, the entertainment sector, and all the other things that make a given location a stimulating place in which to live.

The individuals forming and running advanced technology companies are frequently highly educated. The value they add to the product is brain power. Sometimes all that is required is an inexpensive computer, pencil, and paper. These individuals can live anywhere they choose. Freight is not a factor. I once asked a Ph. D. from Carnegie-Mellon how he happened to settle in a town in southern Ohio of 15,000 people where he produces a super pure silicon chip in competition with some of the majors in the industry. His reply, very simply, was: "I married the daughter of the man who owns that silo down the street, and I love it here. It is a great place to raise kids."

This, of course, is somewhat of an unusual example, but there are a number of interesting high technology companies in Columbus, and we are seeing activity in Oregon, Washington, and places like San Antonio. I even found one in Pittsburgh the other day.

In California, although the company formation rate remains extraordinarily high, there are some serious negatives appearing. Cost of living has skyrocketed. Recently, Barrons made a comparison of the cost of a 2,000-square foot home in a number of U.S. cities. The low figure was $51,000 in Buffalo, with a high of $326,000 in Palo Alto. Columbus, by comparison, came in at approximately $80,000.

We hear frequently that the turnover in California high technology companies is very, very high; rates in the area of 30 to 40 percent annually. I think that's an obvious kind of result. They are scratching for the technical talent out there, pirating from each other.

Some of you may have seen the most recent issue of Time magazine, and I believe the company was Rohm, featuring a sauna, and a swimming pool, and a few other amenities, in an effort to keep employees happy.

Now, what does all this mean for the future? Well, cities like Columbus, in my judgment, with excellent living conditions will be prime candidates as expansion sites for the fast-growing, high technology companies, and, in addition, they will be relatively more attractive as a place in which to start a company.

Once this expansion/formation process begins, it feeds on itself. People break away from the incubator, start their own companies. This was clearly the pattern in Boston and Silicon Valley.

And in my judgment, there is no shortage of technology in the United States or in the State of Ohio. The shortage, if there is one, is in the supply of qualified entrepreneurial businessmen.

However, at the local level, there are probably some things that we ought to be doing, or, perhaps, doing them better, and had I been appearing before you 5 years ago, my list would have been long and directed almost entirely at the Federal Government. However, today, it is relatively short and of local focus.

On the assumption that it's desirable, and I'm not sure it's necessary to have more venture capital located within the State, we might consider a statewide small business investment company. The State or a group of mayors might be the catalyst, with the private capital coming from the financial institutions headquartered here. Such an entity might have offices in Columbus, Cleveland, Cincinnati, and, perhaps, Akron. It should be run by its investors and free of political influence.

The direction of the Small Business Administration is clearly an unknown; however, if licenses are to be granted at all, it would certainly seem that a case for need can be made in the heartland States, especially those where the maturing industries are moving out or declining in activity.

Second, the university system might develop a series of—call them entrepreneurial offices—where the function is primarily one of providing advice, counsel, and, perhaps, the screening of ideas for new company formations. Such offices might even be self-supporting, and have available information as to sources of venture capital, graduate students, faculty members, and retired scientists or engineers who are available for consultation.

Frequently, the entrepreneur or the inventor, and he is usually not the same person, needs education and assistance long before he can attract the necessary capital to launch a company.

Another consideration might be the development of specialized industrial parks where, for example, incentives are provided in order to attract the clean, advanced technology companies. And we are not talking here about research parks, but, rather, those that might appeal to the companies that will become the incubators referred to earlier, such as AccuRay.

It is my understanding that such parks, historically, have had mixed results; however, they well may be appropriate for certain communities.

In summary, the entrepreneur is a free spirit who does not respond well to a forced or a structured environment. Formation of a company is a very voluntary act, and, oftentimes, a traumatic experience. An individual needs advice and patient investors, and given that kind of support, and an attractive environment, he will pay great dividends over time.

Thank you.

[The prepared statement of Mr. James follows:]

SCIENCE AND TECHNOLOGY SUB-COMMITTEE
ON SCIENCE, RESEARCH AND TECHNOLOGY

"LOCAL INCENTIVES FOR HIGH TECHNOLOGY FIRMS"

STATEMENT OF
CHARLES G. JAMES
PRESIDENT
SCIENTIFIC ADVANCES, INC.
FEBRUARY 16, 1982

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE

THANK YOU FOR INVITING ME TO JOIN YOU IN DISCUSSIONS ON A SUBJECT OF GREAT INTEREST TO ALL OF US.

I AM PRESIDENT OF SCIENTIFIC ADVANCES, INC. WHICH IS A WHOLLY-OWNED SUBSIDIARY OF BATTELLE MEMORIAL INSTITUTE. AS MOST OF YOU KNOW BATTELLE IS THE LARGEST INDEPENDENT CONTRACT RESEARCH ORGANIZATION IN THE WORLD. THE INSTITUTE EMPLOYS MORE THAN 7,000 PEOPLE AND HAS FOUR MAJOR LABORATORIES, TWO IN THE UNITED STATES AND TWO IN EUROPE. SCIENTIFIC ADVANCES WAS ORGANIZED IN 1962 AND, ALTHOUGH IT HAS GONE THROUGH VARIOUS PHASES, ITS MISSION ESSENTIALLY IS THE SUPPORT OF SMALL TECHNICALLY INNOVATIVE COMPANIES. THESE COMPANIES MAY BE FORMED WITHIN THE BATTELLE ENVIRONMENT BASED ON PROPRIETARY TECHNOLOGY OR THEY MAY COME TO US FROM WITHOUT. IN ALL CASES WE CALL UPON BATTELLE SCIENTISTS OR ENGINEERS TO ASSIST US IN THE EVALUATION OF THE TECHNOLOGY INVOLVED. CURRENTLY WE HAVE AN INTEREST IN TWO COLUMBUS-BASED COMPANIES, ONE IN CINCINNATI AND THERE ARE OTHERS IN THE AREA THAT RESULTED FROM EARLIER EFFORTS. WE SUPPORT THESE COMPANIES FINANCIALLY, BY FINDING KEY PERSONNEL, IN PLANNING, AND SOMETIMES TECHNICALLY ALTHOUGH WE ARE NOT A VEHICLE FOR FREE RESEARCH. NORMALLY WE DO NOT MANAGE OUR INVESTEE COMPANIES ON A DAY-TO-DAY BASIS. WE ARE EQUITY INVESTORS, WE ARE NOT LENDERS, AND OUR OBJECTIVE IS THE CREATION OF CAPITAL GAINS USUALLY REALIZED OVER A FIVE TO SEVEN YEAR PERIOD. WE DO NOT CHARGE FEES, NOR ARE WE CONSULTANTS IN THE USUAL SENSE, ALTHOUGH A GREAT DEAL OF OUR TIME

IS SPENT IN PROVIDING ADVICE TO ENTREPRENEURS. IN APRIL OF THIS YEAR WE FORMED A LIMITED PARTNERSHIP KNOWN AS THE TECHNOLOGY GROUP IN ORDER TO GIVE OURSELVES GREATER FINANCIAL STRENGTH OVER THE LONGER TERM. OUR PARTNERS ARE MAJOR FINANCIAL INSTITUTIONS AND WE ARE PLEASED TO SAY THAT FOUR COLUMBUS-BASED INSURANCE COMPANIES ARE AMONG THEM. WE DO NOT LIMIT OUR ACTIVITIES TO OHIO, BUT ALL THINGS BEING EQUAL, WE WOULD PREFER TO INVEST IN COMPANIES NEARBY. WITHIN THE SO-CALLED VENTURE CAPITAL INDUSTRY WE ARE UNIQUE; FIRST, BECAUSE OF OUR LINK TO BATTELLE AND ITS ENORMOUS TECHNICAL RESOURCES AND, SECONDLY, BECAUSE OF OUR GEOGRAPHICAL POSITION. WE SHOULD ALSO MENTION THAT WE HAVE A SISTER SUBSIDIARY AT BATTELLE KNOWN AS BATTELLE DEVELOPMENT CORPORATION WHICH IS ACTIVE IN THE LICENSING OF PATENTS AND CURRENTLY HAS MORE THAN A HUNDRED LICENSES OUTSTANDING. THESE PATENTS MAY BE BASED UPON BATTELLE TECHNOLOGY OR INVENTIONS BY OTHERS.

AS MOST OF YOU KNOW THE VENTURE CAPITAL INDUSTRY IS BOOMING TODAY AND BILLIONS OF DOLLARS ARE AVAILABLE THROUGH PRIVATE PARTNERSHIPS, THE SMALL BUSINESS INVESTMENT COMPANIES, AND FROM THE MANY INDIVIDUALS IN COMMUNITIES LIKE COLUMBUS THAT SUPPORT PROMISING ENTREPRENEURS. MOST OF THE VISIBLE CAPITAL IS LOCATED IN BOSTON, NEW YORK, CHICAGO AND ESPECIALLY SAN FRANCISCO. THERE IS RELATIVELY LITTLE IN OHIO AND SOUTH OF CLEVELAND, WE ARE PROBABLY THE LARGEST FIRM IN THE MIDWEST. THERE IS ALSO A CORRESPONDING INCREASE IN THE NUMBER OF ENTREPRENEURS APPEARING. MOST SUBSTANTIAL VENTURE CAPITAL FIRMS ARE REVIEWING 500 TO 1,000 PROPOSALS ANNUALLY. IT IS QUITE POSSIBLE THAT THE DECADE OF THE 80'S WILL BE ONE OF ENTREPRENEURSHIP

AND THAT THE HEROES WILL BE THE PRESIDENTS OF SMALL FAST GROWING TECHNICALLY BASED COMPANIES. CLEARLY IT IS RESPECTABLE ONCE AGAIN TO BE A BUSINESSMAN.

THE REASONS FOR THIS INCREASED ACTIVITY I THINK ARE CLEAR. THERE HAVE BEEN IMPORTANT CHANGES IN THE INTERNAL REVENUE CODE AND REVISIONS IN THE SECURITIES LAW, AND THERE ARE NUMEROUS COMMITTEES AT WORK DEALING WITH THE SUBJECTS OF PATENTS, THE REMOVAL OF UNNECESSARY REGULATIONS, AND SUCH MATTERS AS PRODUCT LIABILITY INSURANCE. MANY OF THE OBSTACLES TO SMALL BUSINESS FORMATION BUILT UP OVER A NUMBER OF YEARS AT THE NATIONAL LEVEL HAVE BEEN OR ARE BEING REMOVED. THIS INCREASED ACTIVITY IS IN SPITE OF RECENT RAMPAGING INFLATION WHICH REMAINS THE SINGLE MOST IMPORTANT THREAT TO SMALL BUSINESSES OF ALL KINDS.

NOW LOOKING TO THE LOCAL SCENE, ASSUMING THE ESSENTIALS OF AN INFRASTRUCTURE IN PLACE, WHAT ARE THE ELEMENTS LEADING TO ADVANCED TECHNOLOGY COMPANY FORMATION. WELL, RIGHT AWAY WE LOOK FOR MODELS AND THAT TAKES US TO SANTA CLARA COUNTY, CALIFORNIA, AND THE WELL-KNOWN ROUTE 128 IN BOSTON. WE HAVE READ THE LITERATURE, ASKED THE QUESTIONS, AND BENEFITED FROM OUR OWN PERSONAL EXPERIENCES WITH COMPANIES IN THOSE AREAS. VARIOUSLY THE ANSWERS ARE:

1. STANFORD UNIVERSITY EARLY ON WAS INVOLVED DIRECTLY OR INDIRECTLY WITH THE SEMICONDUCTOR WHICH LEAD TO THE EXPLOSIVE ELECTRONICS INDUSTRY.

2. IN BOSTON IT WAS THE PRESENCE OF MIT AND ALL THE OTHER GREAT UNIVERSITIES AND PARTICULARLY THE ATTITUDES TOWARD FACULTY INVOLVEMENT WITH SMALL COMPANIES.

3. In California the aerospace industry was a substantially contributing factor with the resulting inflow of engineering talent.

4. In New England the single most important factor was the existence of a large machine tool industry prepared to serve the advanced technologies as the textile industry declined.

5. It was the attitude of financial institutions, that is, the availability of risk capital and the more progressive approaches by bank lending officers.

6. It was simply an accident, or a series of accidents in each case.

All of the above may suggest elements that are important at a given time and place, however, I am convinced that the single most important factor is the so-called quality of life. And by quality of life we mean school systems, park systems, the entertainment sector, and all the other things that make a given location a stimulating place in which to live. The individuals forming and running advanced technology companies are frequently highly educated. The value they add to the product is brain power. Sometimes all that is required is an inexpensive computer, pencil and paper. These individuals can live anywhere they choose, freight is not a factor. I once asked a Ph.D. from Carnegie Mellon how he happened to settle in a town in Southern Ohio of 15,000 people where he produces a super pure silicon chip in competition with some of the majors in the

INDUSTRY. HIS REPLY VERY SIMPLY WAS "I MARRIED THE DAUGHTER OF THE MAN WHO OWNS THAT SILO DOWN THE STREET AND I LOVE IT HERE; IT'S A GREAT PLACE TO RAISE KIDS". THIS, OF COURSE, IS A SOMEWHAT UNUSUAL EXAMPLE BUT THERE ARE A NUMBER OF INTERESTING HIGH TECHNOLOGY COMPANIES IN COLUMBUS AND WE ARE SEEING POCKETS OF ACTIVITY IN OREGON, WASHINGTON, AND PLACES LIKE SAN ANTONIO. IN CALIFORNIA, ALTHOUGH THE COMPANY FORMATION RATE REMAINS HIGH, THERE ARE SOME SERIOUS NEGATIVES APPEARING. THE COST OF LIVING HAS SKYROCKETED. RECENTLY BARRONS MADE A COMPARISON OF THE COST OF A 2,000 SQUARE FOOT HOME IN A NUMBER OF U. S. CITIES. THE LOW FIGURE WAS $51,000 IN BUFFALO WITH THE HIGH $326,000 IN PALO ALTO. COLUMBUS CAME IN AT APPROXIMATELY $80,000. WE HEAR FREQUENTLY THAT CALIFORNIA COMPANIES ARE PLAGUED BY THE TURNOVER OF EMPLOYEES. WE HEAR OF RATES IN THE AREA OF 30 TO 40% ANNUALLY.

NOW WHAT DOES ALL OF THIS MEAN FOR THE FUTURE? WELL, CITIES LIKE COLUMBUS WITH EXCELLENT LIVING CONDITIONS WILL BE PRIME CANDIDATES AS EXPANSION SITES FOR FAST GROWING HIGH TECHNOLOGY COMPANIES AND, IN ADDITION, THEY WILL BE RELATIVELY MORE ATTRACTIVE AS A PLACE IN WHICH TO START A COMPANY. ONCE THIS EXPANSION/FORMATION PROCESS BEGINS, IT FEEDS ON ITSELF. PEOPLE BREAK AWAY FROM THE "INCUBATOR" AND START THEIR OWN COMPANIES. THIS WAS CLEARLY THE PATTERN IN BOSTON AND SILICON VALLEY. AND IN MY JUDGMENT THERE IS NO SHORTAGE OF TECHNOLOGY IN THE UNITED STATES OR IN THE STATE OF OHIO. THE SHORTAGE, IF THERE IS ONE, IS IN THE SUPPLY OF QUALIFIED ENTREPRENEURIAL BUSINESSMEN.

However, at the local level there are probably some things that we ought to be doing or perhaps doing them better. Had I been appearing before you five years ago my list would have been long and directed almost entirely at the Federal Government, however, today it is relatively short and of local focus.

1. On the assumption that its desirable, and I am not sure that its necessary, to have more venture capital located within the State, we might consider a state-wide small business investment company. The State, or a group of mayors, might be the catalyst with the private capital coming from the financial institutions headquartered here. Such an entity might have offices in Columbus, Cleveland, Cincinnati, and perhaps Akron. It should be run by its investors and free of political influence. The direction of the Small Business Administration is clearly an unknown; however, if licenses are to be granted at all, it would certainly seem that a case for need can be made in the heartland states, especially those where the maturing industries are moving out or declining in activity.
2. The university system might develop a series of "entrepreneurial" offices where the function is primarily one of providing advice, counsel, and perhaps the screening of ideas for new company

FORMATIONS. SUCH OFFICES MIGHT EVEN BE SELF-SUPPORTING AND HAVE AVAILABLE INFORMATION AS TO SOURCES OF VENTURE CAPITAL, GRADUATE STUDENTS, FACULTY MEMBERS AND RETIRED SCIENTISTS OR ENGINEERS WHO ARE AVAILABLE FOR CONSULTATION. FREQUENTLY THE ENTREPRENEUR OR THE INVENTOR, AND HE IS USUALLY NOT THE SAME PERSON, NEEDS EDUCATION AND ASSISTANCE LONG BEFORE HE CAN ATTRACT THE NECESSARY CAPITAL TO LAUNCH A COMPANY.

3. ANOTHER CONSIDERATION MIGHT BE THE DEVELOPMENT OF SPECIALIZED INDUSTRIAL PARKS WHERE, FOR EXAMPLE, INCENTIVES ARE PROVIDED IN ORDER TO ATTRACT THE CLEAN ADVANCED TECHNOLOGY COMPANIES. WE ARE NOT TALKING HERE ABOUT A RESEARCH PARK BUT RATHER ONE THAT MIGHT APPEAL TO THOSE COMPANIES THAT WILL BECOME THE INCUBATORS REFERRED TO EARLIER. IT'S MY UNDERSTANDING THAT SUCH PARKS HISTORICALLY HAVE HAD MIXED RESULTS, HOWEVER, THEY MAY WELL BE APPROPRIATE FOR CERTAIN COMMUNITIES.

IN SUMMARY, THE ENTREPRENEUR IS A FREE SPIRIT WHO DOESN'T RESPOND WELL TO A FORCED OR STRUCTURED ENVIRONMENT. THE FORMATION OF A COMPANY IS A VERY VOLUNTARY ACT AND OFTEN TIMES A TRAUMATIC EXPERIENCE. THE INDIVIDUAL NEEDS ADVICE AND PATIENT INVESTORS. GIVEN THAT KIND OF SUPPORT AND AN ATTRACTIVE ENVIRONMENT, HE WILL PAY GREAT DIVIDENDS OVER TIME.

Mr. **Shamansky**. Mr. Moore.

Mr. **Moore**. Mr. Chairman and Members of the House Subcommittee, I would also like to thank you for allowing me to present my testimony this morning on a subject which, as others have mentioned, is of critical importance to the vitality of the economy of this Nation as a whole, and the industrial northeast end of Ohio, in particular.

I am a partner, in charge of tax services for the Columbus office of Coopers and Lybrand, international public accounting firm.

Locally, we have a group of 200 professionals serving the needs of the business community and practice areas, such as accounting and auditing, management consulting, actuarial benefits, compensation consulting, and tax and financial planning. We have approximately 90 offices in the United States, and 350 worldwide in some 90 countries. Our partner and staff group consists worldwide of about 25,000 professionals, with anticipated revenues for this year of over $1 billion.

While our client base varies from the largest multinational companies to some of the smallest sole proprietorships, the vast majority of our clients in terms of numbers range in the small entrepreneurial-minded enterprise classification.

In recognition of this fact, we have formed firm-wide a separate high technology industry group within the firm, and a special emerging business services group in the Columbus office. We have pioneered the use of the R. & D. partnership vehicle to raise high risk capital for research and development activities, and have worked closely with banks, the SBA, the SBIC's, and other various private capital sources, to further the economic success of our clients.

We have been involved with many local high technology companies in providing financial, advisory, accounting, and tax services from formation to mature business stages. This involvement includes recommendations as to the business form to be employed; for example, a sole proprietorship, partnership, general or limited, corporation, and so forth. It also includes advice at the levels of capitalization required, sources of equity and debt financing, tax and financial accounting methods to be employed, and so forth.

By providing an entree of local business enterprises to the international firm network, we have also assisted in overseas market expansion through our own overseas offices and through the creation of overseas subsidiaries and branches by our corporate clients, and in the area of acquisitions, reorganizations, and corporate adjustments to improve the economic performance of our clients.

In terms of the specific questions I have been asked to address today relative to local market incentives, I can only stress the points made earlier regarding local infra-structure. This would include roads and transportation facilities which impact market access, strong public and private educational facilities which groom our citizens, and provide the tools and productive skills necessary, and provide access to the people and ideas which drive high technology enterprises.

High technology enterprises, as has been mentioned earlier, are principally people oriented kinds of businesses. They're not limited to locations offering an abundance of cheap raw materials or cheap labor, but will be in environments where the access to new technology, where risk-taking is encouraged, where support of public and private education is strong, and where job training and job retraining programs are strongly supported.

High tech businesses tend to function somewhat as breeder reactors, as has been mentioned earlier. They tend to feed on themselves, and then, through spinoffs, create other business enterprises. They can generally be found near the sources of research activities where technology study is fostered, and where data relative to technological developments is stored.

We are most fortunate in central Ohio to have a number of institutions of this type present. I mention the Ohio State University, Battelle Memorial Laboratories, and Chemical Abstracts as outstanding examples.

Many of the local high technology businesses have originated based on applications of technology developed or stored in these institutions.

Knowledge transfer from institutions such as these to commercial businesses has happened informally, through transfers of personnel, as well as through more formal processes, such as licensing. This is a segment of the high technology business formation issue which can clearly be strengthened, however, as has been mentioned earlier. It's critical that we establish more formal and more widely understood procedures where the private sector can access technology developed or stored in institutions of this type and entrepreneurial skills resident in the private sector can be brought to bear on identifying practical applications of this technology, and in identifying markets and marshalling the capital and labor resources necessary to produce a worthwhile product.

As a tax practitioner, and given the background for entrepreneurs, no discussion of this type would be complete without a substantial amount of time devoted to requested changes in Federal income rules. I work in the tax business every day. I think what we have seen in terms of the tax adjustments coming through the last round of tax reforms on mechanisms for credits for R. & D. expenditures, the accelerated cost recovery system, substantial reduced rates on long-term capital gains, provide a pretty solid base from the standpoint of taxation on high tech businesses and on newly forming businesses.

Most high technology start-up enterprises pay little or no Federal income taxes anyway, at present. The ability to expense R. & D. costs, as well as accelerated capital allowances, coupled with the high interest rates we are currently experiencing, generally results in tax loss carried forward for enterprises of these types.

Going on to a little larger question, a great deal of discussion has occurred over the last several years concerning the need to increase the rate of capital formation in the private sector. This clearly may be the most critical factor currently impacting the formation and success rate of high technology enterprises. Satisfying capital needs in the most efficient manner has become one of the principal concerns of these enterprises, and is an area where management has been forced to devote more and more attention.

Widespread disarray in the capital markets has led to tragic business failure rates, and has severely restricted the growth levels of other more successful enterprises.

No discussion of local incentives to business formation can be complete without reference to the disastrous impact currently felt from the extreme volatility in the national credit markets.

The formation of private capital to finance start-up and expansion of these enterprises is only one piece of the equation. The second is the willingness of the credit markets to commit that capital at reasonable costs to relatively long-term investment. We are rapidly becoming a nation of exceedingly short-term investors. This philosophy, if not reversed soon, will place a severe limiting factor on the business formation rate and on the ability of high technology firms to grow and to provide the kind of employment opportunities that we need.

Thank you.

[The prepared statement of Mr. Moore follows:]

Testimony of James A. Moore, Jr.
Partner in Charge of Tax Services,
Coopers & Lybrand, Columbus

House of Representatives
Science and Technology Subcommittee on
Science Research and Technology

Hearings on "Local Incentives for High Technology Firms and Innovation
February 16, 1982, COSI Auditorium, Columbus, Ohio
Chairman: Hon. Douglas Walgren
Sponsor: Hon. Robert Shamansky

Chairman and members of the House Subcommittee on Science, Research, and Technology;

I first want to thank you for allowing me the opportunity to present testimony on a subject of critical importance to the vitality of the economy of the nation as a whole and of the Industrial Northeast and Ohio in particular. I am Partner-in-Charge of Tax Services for the Columbus office, Coopers & Lybrand. Locally we have a group of over 200 professionals serving the needs of the business community in practice areas such as accounting and auditing, management consulting, actuarial benefits, compensation consulting and tax and financial planning. We have approximately 90 offices in the U.S. and 350 world wide in some 90 countries. Our partner and staff group world wide exceeds 25,000 professionals with revenues for this fiscal year budgeted to exceed one billion dollars. While our client base varies from the largest multinationals to the smallest sole proprietorships, the vast majority of our clients number in the small, entrepreneurial minded enterprise classification. In recognition of this fact we have formed a separate High Technology Industry Group within the firm and a specialty Emerging Business Services Group in the Columbus Office.

We have pioneered the use of the R & D partnership vehicle to raise high risk capital for research and development activities and have worked closely with banks, the SBA, SBIC's and various private capital sources to further the economic success of our clients.

We have been involved in many local high technology companies in providing financial advisory, accounting and tax services from formation to mature stages. This involvement includes recommendations as to the business form to be employed, e.g. sole proprietorship, partnership, general or limited, corporation etc. It also includes advice as to levels of capitalization, sources of equity and debt financing, franchise arrangements, marketing arrangements such as sales or lease financing, tax and financial accounting methods to be employed and so forth. By providing the entre' of local business enterprises to our international firm network, we have assisted in overseas market expansion through overseas subsidiaries and branches and in acquisitions, reorganizations and corporate adjustments to improve economic performance.

In terms of the specific questions I have been asked to address relative to local market incentives, I can only stress the points made earlier regarding local infra-structure. This would include roads and transportation facilities which impact market access, strong public and private educational facilities which groom our citizens and provide the tools and productive skills necessary and provide access to the people and ideas which drive High-Tech enterprises. High-Tech enterprises are principally people oriented. They are generally not limited to locations offering an abundance of cheap raw materials or cheap labor, but will be found in environments where access to new technology is open, where risk taking is encouraged, where support of public and private education is strong and where job training and retraining programs are strongly supported.

High-Tech businesses tend to function somewhat as breeder reactors. They can generally be found near the sources of research activities where technological study is fostered and where data relative to technological developments is stored. We are most fortunate in Central Ohio to have a number of institutions of this type present. I mention the Ohio State University, Battelle Labs and Chemical Abstracts as outstanding examples. Many of the local High-Tech businesses have originated based on applications of technology developed or stored in these institutions. The knowledge transfer process from institutions such as these to commercial businesses has happened informally through transfers of personnel as well as through more formal processes such as licensing. This is a segment of the High-Tech business formation issue which can clearly be strenghthened, however. It is critical that we establish more formal and widely understood procedures where the private sector can access technology developed or stored in these types of institutions and entrepreneurial skills resident in the private sector can be brought to bear on identifying practical applications of this technology, in identifying markets and marshalling the capital and labor resources necessary to produce a worthwhile product.

Additional incentives at the federal level in the form of tax reductions through the mechanisms for credits for R & D expenditures, Accelerated Cost Recovery and substantially reduced rates on long term capital gains provided in the last round of income tax reforms provide a solid base from the standpoint of taxation and further relief in this area does not seem to be warranted. Most High-Tech start up enterprises pay little or no federal income taxes at present. The ability to expense R & D costs as well as accelerated capital allowances coupled with high interest costs and marginal profitability in the early years generally results in tax loss carryforwards for most companies of this type.

An area where some federal review might be warranted, however, concerns the lending practices of certain banks and their interrelationships with the SBA loan guarantee program. Under current rules, banks are permitted to charge up to 2 3/4 points over the prime lending rate. This is permitted in spite of the fact that these loans are up to 90% guaranteed by the government. In today's market, 90% guaranteed loans can be priced to yield nearly 19%. This has caused an after market in packaged guaranteed loans in the 14%-15% range for the 90% guaranteed portion. By selling this portion of the loan off, packaging banks are able to achieve rates in the 40%-50% range on the 10% of the loan balance they have at risk. This practice should be discouraged by placing reasonable limits on the rates which can be charged on guaranteed loans thereby passing the benefit of federal guarantees to those small businesses for which they are intended rather than to the intermediary financial institution.

A great deal of discussion has occurred over the last several years concerning the need to increase the rate of capital formation in the private sector. This clearly may be the most critical factor impacting the formation and success rates of High-Tech enterprises. Satisfying capital needs in the most efficient manner has become one of the principal concerns of these enterprises, and is an area where management has been forced to devote more and more attention. Wide spread disarray in the capital markets has led to tragic business failure rates and has severely restricted growth levels of other more successful enterprises. No discussion of local incentives to business formation can be complete without reference to the disastrous impact currently felt from the extreme volatility in the national credit markets. The formation of private capital to finance start-up and expansion of these enterprises is only one piece of the equation. The second is the willingness of credit markets to commit that capital at reasonable cost to relatively long term investment. We are very rapidly becoming a nation of exceedingly short term investors. This philosophy, if not reversed soon will place a severe limiting factor on the business formation rate and on the ability of High-Tech firms to grow and provide the kind of employment opportunities needed.

We are witnessing in Ohio what can be described as nothing short of a collapse of traditional industries such as steel, automotive, housing and mining brought on by radical shifts in the costs of energy and capital. Interest rates in real terms, that is the interest rate over the underlying inflation rate, are at levels not witnessed since the eighteenth century. This dramatic increase in real interest costs has had a two-fold effect on an Ohio economy heavily dependent on mature capital intensive industries on exports. It has substantially increased the cost of doing business while sharply lowering demand both in the domestic market and overseas where due to abnormal interest rates the dollar has risen over 30% on average against most European currencies.

Current interest rates go far beyond compensating lenders for the effect of inflation on erosion of principal. They impose a real and substantial hardship on borrowers. From a source of capital standpoint they also radically change the traditional mix between short and long term debt investments and equity investments with a strong bias toward high yield short term investments.

As regards High-Tech business formation, this trend spells substantial problems. Business cannot plan orderly growth and expansion where debt service costs fluctuate daily or weekly and swing radically over very short periods of time in response to crudely perceived increases or decreases in the money supply. We all laud the efforts of the Fed to bring inflation under control but monetary policy is proving to be a very blunt instrument in dealing with the kind of institutionalized stagflation we have experienced over a good part of the last decade. Other tools must be considered at the national level to bring some sort of stability to the credit markets.

What we are seeing now has been called a collision between stimulative fiscal policies, i.e. tax reductions and increased defense spending levels, and restrictive monetary policies which creates increased upward pressures on interest rates well beyond underlying inflationary levels. This economy is clearly not conducive to the type of investments necessary to translate technological advances into the types of products which will provide critical improvements in levels of productivity. Until this situation is corrected, local conditions fostering formation of High-Tech businesses will be largely irrelevant.

Mr. **Shamansky**. I want to tell the panel that I have been holding back on questions. I have the prerogative of initiating the questions. But this is the area that I have been especially concerned with.

Chuck James and I have been talking about this for a long time. Picking up on the themes presented by George Foster, and the others, and mentioning that Frank Woibst, the chairman of Huntington Bank Shares, told me that there is capital available by an individual willing to risk it, do you feel, as I have heard Ohio State Professor Al Shapiro claim, that the venture capital firms come in a little late? In other words, I would like your views on the risk-taking investor being able to find the inventor, and you distinguished him from the entrepreneur. How do these people get together and what have we done here in the past to help them get together? And, two, what should we be doing to help them get together?

Mr. **James**. I don't think a great deal has been done in Columbus or in central Ohio—I have been back here what, 8 years—to help them get together.

Just to be expansive for 1 second, the single most important problem, in my judgment, is the inventor and where to send him, how to deal with him. He is so critically important at that very, very early stage, but there are very few places in this country that you can send the inventor for help.

So it happens very informally. He gets a few thousand dollars from a neighbor, or a friend, or somebody who believes in the widget, and he fiddles around in the garage. There are innovation centers in Utah. I think Carnegie-Mellon has one, as a matter of fact. Atlanta is working on one. That is at a stage. That is not what we call venture capital. That's something else by my definition. And I might say that no venture capitalists agree either on the definition of what it is, or on what makes a good venture, but the inventor is a particular problem.

Now, as you move on up the stage of development, let's say of a tecnnical widget, toward commercial application, it comes much easier, then, of course. It is less risky. It is still terrifying, but it is less risky. There you can find 300 or 400 names in directories in business libraries and so forth as to what firms are interested in investing. So, you get, then, into the formal structures nationwide; the SBIC's and the private partnerships.

Now, as to how you find out about individuals in a community who are willing to take a flyer on a given enterprise, darned if I know. When I am advising an individual, I say talk to your banker, talk to your lawyer, talk to your accountant. Usually, they will know about individuals with an appetite for that kind of investing.

Mr. **Shamansky**. Do you think that this community could as a practical matter develop a backlog, a list of people, who are willing to make this kind of investment?

Mr. **James**. As a practical matter, I wouldn't want to be on that list, not in today's society. And the people who supply those amounts of capital, I don't think would want to be listed.

Mr. **Moore**. If I could just deal with that for a second, I have clients on both sides of the spectrum. I have a large number of individual clients that are reasonably well-to-do and have been successful in the past who are looking for investment opportunities. A lot of small shop operations that Chuck James had mentioned where the guys gets a loan from his neighbor and wants to know what the next step is, a lot of those guys come through my office.

It is very difficult to do that kind of a matching process. Most people that—especially, in this market, and I don't think you can go away from what we're dealing with now in February 1982. We can't go back to 1980, because it is a different ball game. Those people do not want to make long-term high risk investments.

If a substantial individual investor can get 15 to 18 percent on his money, rate of return which, free of Federal income taxes, equates to a 30- and 35-percent pretax equivalent rate of return, he is not going to make venture capital investments in high technology operations regardless of what the tax incentives are. That is not going to happen.

So, until we get some controls in the capital markets, and can get some flexibility and stability in the interest rate structure, so we are all dealing with real numbers, there are going to be substantial problems, whether it is Columbus, or wherever.

Mr. **James**. I want to follow that thought for a moment. Although that is true for the individual investor, however, that kind of thinking does not necessarily prevail within the institutional investor, i.e. the pension funds. After all, the pension funds own the country nearly—or the insurance companies and so forth. Theirs is a different, longer term, kind of philosophy. Most, not all certainly, but many have set aside 1 or 2 percent of their total capital to be devoted to venture capital activities. Major sources are pension funds today.

Mr. **Shamansky**. Thank you. Mr. Chairman.

Mr. **Walgren**. Mr. Moore stopped short of the end of his testimony—not that he was holding anything back—in which he talked about the collision between the fiscal policy and the monetary policy and the fact that current interest rates are at levels not witnessed since the 18th century.

And we are confronted with the general feeling that these interest rates are related to the demands of the Government upon the capital market.

In the Wall Street Journal this morning it said that under the Reagan budget 60 percent of the savings will be taken up by Government borrowing. We are facing a $91 billion deficit. That deficit assumes a $13 billion increase in taxes not yet passed by the Congress, and a $43 billion reduction in Government spending not yet approved by the Congress. There are fudge factors in there, such as $18 billion in revenue from off-shore oil leases, and if you just average out what any of us can anticipate, we are probably looking at a budget deficit somewhere in the range of $150 billion. This, after 1977, when we were in the $27 billion range.

Now, how do we react to that, when the interest rates are what are really devastating this kind of economy?

Mr. **James**. Well, I am not an economist. However, since there are very few experts on that subject, we all kind of drink our own bath water. We all read the Wall Street Journal and we all view "Face The Nation" on Sunday morning.

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But, my lay response is that interest rates in the long term, forgetting this collison that you are talking about, have all of us, I think, worried. Interest rates in the long term are a function of inflation purely and simply.

If you are a mortgage lender, if you are a bond buyer, or whatever—historically, my understanding is, the real rate of interest has been 3½, 4 percent, give or take. So, then you add inflation to that. So, if the expectation is that we are going to continue at 7, 8, or 10 percent inflation, then add another 3 or 4 percent to it, I guess.

But, I must say that given what has happened the last 3 or 4 years, I don't know where we stand on the swings of the pendulum. I am just as uneasy as I'm sure you are as to what this collision brings. I hope we can survive it and come out on the other side with much lower rates.

Mr. **Moore**. I think what we are seeing now, and what we've seen really for some time, is that the real underlying interest rates are not really bearing in a relationship to the inflation rate, and probably have not since the sixties. It is more a function of the supply and demand for currency, or may be a function for the supply and demand for currency as much as the underlying inflation rate we were in through the sixties where interest rates, generally, ran well short of inflation rates. So, that we had really negative borrowing cost through the sixties and in the early seventies. It encouraged a lot of us to recommend expansion-oriented schemes that relied heavily on debt. Now, we see the absolute—the reverse of that situation where rates again are out of whack with the underlying inflation rate, but more attuned to the supply and demand for currency.

We have a policy—a Federal policy—that would call for stimulation of the economy to the tune of $100 to $150 billion in terms of additional deficits next year. You have to look at the other side of that equation and that is, well, what is going to happen to those funds?

It doesn't really make any difference, I don't think, if you have got free funds injected from a large deficit caused by tax cuts and increased defense spending, or whether it is sloppy financial budgeting on the expenditure side. The net result, as far as the economy, it runs pretty close to the same, if the Fed persists in their policy, and I think they probably will, of not monetizing those kinds of deficits. You are right back against the interest rate crunch and I think that is what has caused rates to tick back up here recently.

Mr. **Shamansky**. Thank you. Congressman Ertel.

Mr. **Ertel**. Thank you, Mr. Shamansky.

Mr. James, you mentioned the innovative centers at Carnegie-Mellon, and also in Utah. I would just like to point out to you that those two centers were supported by NSF funds. And I want to tell you that they have been zeroed out for 1983.

Mr. **James**. I am not surprised, and there was one in Oregon, and I have a feeling it is out of business, too.

But are you talking about a budget consideration, or because they didn't perform?

One of the things I don't know, Congressman, is how successful——

Mr. ERTEL. Well, my judgment is that they were budgeted out. Not because they did not perform. I am familiar with the one in Pittsburgh.

Mr. JAMES. I don't know what their success has been.

Mr. ERTEL. Well, I just wanted to let you know that they won't be any longer in existence if it requires Federal funding. They are done.

Both of you have testified about availability of capital. And I happen to agree very much with what you said, Mr. Moore, as to where we are going, and subscribe to Mr. Walgren's thesis. We are not going anywhere at this point, so long as we continue the activities of a large deficit, which is going to cause high interest rates, as long as we are not going to monetize that debt. And the Fed has already indicated that they are not going to do that. I don't see what else you can do.

My question is that you told us the problem, and you told us what is happening, what do you recommend for the solution?

Mr. MOORE. Well, that is not really my purview. I think—I can see where the problems are developing and I know what concerns bankers and other elements of our client base in terms of where rates are moving and what is going to happen to the course of capital formation.

There are a number of ways to control inflation. Restrictions on the money supply is but one. Maybe some other alternative should be looked at more closely.

Mr. ERTEL. Well, you submitted in your prepared statement, and I don't believe you read this:

> What we are seeing now has been called a collision between stimulative fiscal policies; i.e., tax reductions and increased defense spending levels, and restrictive monetary policies which create increased upward pressures on interest rates well beyond underlying inflationary levels.

If I were to read that, I guess, putting my own gloss on it, you are telling us we ought to be decreasing defense spending levels. Is that right?

Mr. MOORE. Well, we ought to be doing something to try to pare the budget more in line. I am not going to recommend any alternatives as to whether it comes on the social side, or the defense side, or on the tax increase side. But, clearly, the concern, I think, now, is that if this budget is going to have a stimulative effect of a minimum of $90 billion and possibly in the $100 to $150 range, there are some—I think there are some real concerns in Columbus, Ohio and a lot of other places.

Mr. ERTEL. Well, I don't want to press too much, but I certainly am trying to get an answer out of you, and I am going to stay at it for a bit, if I might. You said tax reductions, increased defense spending levels, and restrictive monetary policies. Now, that is three things.

Now, what do you recommend we change about those three things from a national perspective? And we are interested in that because it does impact on both, Columbus and the nation as a whole. What do you recommend we do with those three areas?

Are you suggesting tax increases? Are you suggesting decreased defense spending, or are you suggesting monetizing the debt?

Mr. **Moore**. I think all—I am not really suggesting monetizing the debt. I think we have been through that.

Mr. **Ertel**. OK, so that leaves two.

Mr. **Moore**. I think that we have got to take a look at all of those alternatives, and I think that is one of the things that this Congress is, hopefully, going to address. There are a number of factors in the mix, the tax decreases that have already taken place and are scheduled to take place—the step down is scheduled for July, I think. Some of those things have to be looked at. The magnitude of the defense budget has to be looked at, I think, as well as the social programs. All of those things that are contributing to the magnitude of that deficit, I think, have got to get another review.

Mr. **Ertel**. Do you have a suggestion where we should come out?

Mr. **Moore**. Somewhere short of $150 billion in the red.

Mr. **Ertel**. I agree with everything you have said, but I've got to tell you that though I appreciate what you have said, we are going to vote on these things. You are constituents of the United States, and somewhere we look for advice from our constituencies. And you have sort of hedged a bit, more than a bit, completely. I just wondered if you had a specific——

Mr. **Moore**. I didn't really mean to give that impression. I was just suggesting that there are a number of factors in that mix and I think they all have to be looked at.

Mr. **Ertel**. Thank you.

Mr. **Shamansky**. Thank you, Mr. Ertel. Mrs. Schneider.

Mrs. **Schneider**. Mr. James, in your testimony you indicated that if you were testifying 5 years ago today, you would have had a long list of recommendations, primarily for the Federal Government. I am curious to learn what has happened in the last 5 years that causes you now to focus, primarily, on State and local involvement in getting high tech and innovation efforts under way?

Mr. **James**. Well, first of all, the request of this committee. But you had the change in the capital gains tax in 1978 which was vigorously opposed by the administration. Then, we had the White House Conference on Small Business. A lot of activity coming out of that. A lot of committees. I was on a couple sponsored by the SBA, sponsored by the Congress, by the executive branch, and so forth, dealing with every variety of subject, long overdue. Forces converged, in my judgment, over a 15-year period, which made it virtually impossible to start and operate a small business in this country, especially a high technology small business, where you have very fast growth, and where you have high risk products, perhaps, the insurance question, and things of that nature.

Now, many of those have been dealt with, and I think dealt with adequately. The stock option thing mentioned by George Foster, little known and meaningless to the person running a filling station but critically important to the fellow starting a high technology company where he can't afford the high salaries to draw the talent away from General Electric or Westinghouse. But, if he can offer a big future, he can get that talent.

In California, the name of the game is start your company, get a stock option, and buy a Mercedes, in that order.

You know, there is a spirit out there. It is happening. Time Magazine underscored this. I agree with 90 percent of the remarks in the article.

Mr. **Walgren.** Provided the Mercedes is a business expense and deductible against the——

Mr. **James.** That is critically important in California.

Mr. **Ertel.** Maybe he should have bought a Cadillac instead. American made.

Mr. **James.** Or a Ford, yeah.

Mr. **Walgren.** This is one of my pet peeves. I used to live next to a fellow who ran a small entrepreneurial accounting firm. He had at least $40,000 worth of German automobiles sitting in his driveway, and they were all tax deductible. I saw myself paying for that excess, and not even American excess, and somehow or other, that never gets addressed in our revisions.

Is there a way that could be addressed?

Mr. **Moore.** Well, you have the statutory framework to deal with that issue now. In order for an expense to be deductible for income tax purposes, it has to be ordinary, necessary, and reasonable in amount.

Mr. **Walgren.** I see. I am sorry, I interrupted. Mrs. Schneider?

Mrs. **Schneider.** No; I was finished. Thank you.

Mr. **Shamansky.** I think we will now shift to the next panel, but first I have to note that Mrs. Schneider has to catch an airplane, and I want to thank her very much for coming from Rhode Island just for this hearing. Thank you, Congresswoman Schneider.

Mr. **Shamansky.** Our next witnesses are Dr. Edward W. Ungar, director of the Columbus Division of Battelle Memorial Institute, and Mr. Lynn Elfner, executive officer of the Ohio Academy of Science.

We are happy to have your testimony.

STATEMENTS OF EDWARD W. UNGAR, DIRECTOR OF BATTELLE MEMORIAL INSTITUTE, COLUMBUS DIVISION AND LYNN ELFNER, EXECUTIVE OFFICER, OHIO ACADEMY OF SCIENCE

Mr. **Ungar.** Mr. Chairman, members of the House Science and Technology Subcommittee on Science, Research, and Technology, I would like to thank you for inviting me, and I would like to, also, welcome you to Columbus.

As a vice president of Battelle Memorial Institute, and the director of Battelle's Columbus Division, I am honored to have the opportunity to share my perspectives on what attracts high technology firms to a community. I might also add that in the interest of time, I will skip some of the more interesting parts of my talk. You have that in your prepared comments. I, also, appreciate the comments of the previous speakers who covered some of the material that I was going to cover this morning.

Today I am going to focus on the far reaching impacts of contract research and development of organizations like ours. I believe that there are numerous benefits that a community derives from the presence of R. & D. organizations. And high technology companies tend to spring up in locations where there is a close geographic proximity of research-oriented universities, R. & D. oriented companies, accompanying populations of scientists and engineers and sources of venture capital. Central Ohio does have these ingredients. I think technology organizations beget the technology organizations.

You have all heard about Battelle from the previous speakers. We have several organizations, several parts of our organization located here in Columbus; the Columbus Division, Columbus Laboratories, the Project Management Division, and two subsidiaries for licensing and commercializing technology. Mr. James is president of one of those. We also have divisions in Richland, Wash.; Geneva, Switzerland; and Frankfurt, West Germany.

Here in Columbus, our division employees, over 3,000 staff members, in 1981 performed over $121 million worth of contract research with more than 40 percent of that for industry.

In 1981 nearly 14 percent of our industrial research was done for Ohio-based companies, and 24 percent of our research was done for Ohio-based government agencies. And in spite of some decline in total staff during 1981, we have shown good growth over the past 5 years with a staff increase of about 16 percent, and a research volume increase of 47 percent, and what may be more important to the region, an increase in our payroll of 57 percent.

We see ourselves as a bridge between government and industry. Our experience with the government allows us to apply the technologies that we learned and use them in the private sector.

I think that our problem-solving capability can be focused very well, and I think the example of AccuRay was mentioned before. I think we have an ability to focus this capability onto large and small companies, and particularly to help the small company during their startup phase.

I would like to mention one other area. Two years ago there was a great deal of interest in the concept of generic technology centers, so-called cogents, which were funded and managed by the Government. In effect, such centers already exist in the private sector. Contract research and development organizations, such as ours, offer private sector mechanisms for cooperative research and development.

The Battelle approach to generic research is something that we are already doing successfully. We call it group or multi-client research. It is a proven method of pooling investments of several companies into a single study of a general, non-proprietary problem, and distributing results to participating companies for use in their own plants and facilities. We are currently conducting 25 of these programs with 550 member companies. I just mentioned one example. There are several in the testimony. We are conducting a program on developing ceramic shapes by injection molding. Specialists are developing approaches for manufacturers to use injection molding equipment. These are originally designed for plastics and we are now applying them to high temperature durable ceramic parts. There are 39 companies participating in this program which is funded at about a $1 million level. There are a number of other examples in the written testimony.

I might mention that we don't merely transfer technology to industry, we work with the industries in order to help them implement the technology and to create, or improve, specific products and processes. An example cited by a previous speaker was the Xerox process. We, too, regret that Xerox Corp. is not located in Ohio.

However, another example of implementation of research closer to home is with the Wooster Brush Co. We served in the role of Wooster Brush's research arm since 1950, when Wooster was a small business firm specializing in high quality crafted paintbrushes.

Today, Wooster is the world's largest manufacturer of paintbrushes. Wooster has introduced a wide range of Battelle innovations over the years.

We are now involved in commercializing an innovative new development called multi-solid, fluidized bed combustion. We are doing this through one of our subsidiaries, the Battelle Development Corp., and through licensees, most notably, Struthers Wells Corp.

This process burns various high sulphur fuels and does this in an environmentally acceptable, and a highly cost-effective way. It is being used in its first industrial application now for steam flooding of oil wells. We expect it will have other uses in the future burning high sulphur coal, shale oil, waste fuel process, and for burning a variety of low grade fuels to process steam.

These are just a few examples, there are many examples of Battelle technology making a difference, but time doesn't allow me to go in to all of these.

There is another positive contribution that a research and development organization makes in a community, and that occurs when bright, innovative staff members leave to start up their own company. Of course, we are not happy to lose these people, but we are proud of their contributions toward the technological base in our community.

In Columbus, for instance, there are eight small companies established by former staff members. Their products include coating systems, various materials such as metals, and fibers, and laser technology. Some of these companies are based on Battelle-developed technology.

I think I would like to second the comment that was made by a previous speaker with regard to the attributes of the community that attracts high technology organizations. I think that a recent study by Industrial Research Magazine examines selection criteria for research, development, and engineering firms. The criteria included: available professional staff, technical staff, proximity to support staff, transportation facilities, and quality of life variables like public and higher education, housing, medical and recreational facilities, low crime, aesthetically pleasing community, worker-community attitudes, and so on. And the point is the good quality of life. And I think Columbus has all of these.

I also applaud the Columbus Area Chamber of Commerce for its role in creating widespread awareness of these attributes by establishing a committee which is examining what can be done to attract innovative high technology industry to Columbus.

And I also commend the Congress on the recent passage of the research and development tax credit. This credit, along with accelerated depreciation, should stimulate industrial research and development activities and innovation in the United States. And I believe in our business we are now seeing some effect of that.

In this presentation, I have tried to describe some impacts of the research and development organization, and characteristics of the community to attract high technology industry. Innovation is going to be the key ingredient to our country's future. And communities like Columbus, Ohio, with their technological orientation, will play an increasingly vital role.

Thank you.

[The prepared statement of Dr. Ungar follows:]

SUBCOMMITTEE ON SCIENCE,
RESEARCH AND TECHNOLOGY

HEARINGS ON LOCAL INCENTIVES FOR HIGH-TECHNOLOGY FIRMS AND INNOVATION

STATEMENT OF

EDWARD W. UNGAR
DIRECTOR

BATTELLE'S COLUMBUS DIVISION

FEBRUARY 16, 1982

MR. CHAIRMAN AND MEMBERS OF THE HOUSE SCIENCE AND TECHNOLOGY SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY; THANK YOU FOR INVITING ME TO SPEAK WITH YOU TODAY. AS A VICE PRESIDENT OF BATTELLE MEMORIAL INSTITUTE, AND THE DIRECTOR OF BATTELLE'S COLUMBUS DIVISION, I AM HONORED TO HAVE THE OPPORTUNITY TO SHARE MY PERSPECTIVES ON WHAT ATTRACTS HIGH TECHNOLOGY FIRMS TO A COMMUNITY.

TODAY, I WILL FOCUS ON SOME OF THE FAR-REACHING IMPACTS OF CONTRACT RESEARCH AND DEVELOPMENT ORGANIZATIONS LIKE BATTELLE.

THERE ARE NUMEROUS BENEFITS THAT A COMMUNITY DERIVES FROM THE PRESENCE OF RESEARCH AND DEVELOPMENT ORGANIZATIONS. HIGH TECHNOLOGY COMPANIES TEND TO SPRING UP IN LOCATIONS WHERE THERE IS CLOSE GEOGRAPHIC PROXIMITY OF RESEARCH-ORIENTED UNIVERSITIES, R&D-ORIENTED COMPANIES, ACCOMPANYING POPULATIONS OF SCIENTISTS AND ENGINEERS, AND SOURCES OF VENTURE CAPITAL. CENTRAL OHIO HAS ALL THESE INGREDIENTS. BRIEFLY, I WILL:

- DESCRIBE WHAT BATTELLE IS AND WHAT IT DOES;
- DISCUSS A SUCCESSFUL PRIVATE-SECTOR APPROACH TO CONDUCTING COOPERATIVE RESEARCH;
- EXPLAIN HOW A CONTRACT RESEARCH ORGANIZATION HELPS INDUSTRY AND GOVERNMENT IMPLEMENT TECHNOLOGY; AND
- OUTLINE A FEW COMMUNITY CHARACTERISTICS THAT ARE HELPFUL IN ATTRACTING HIGH-TECHNOLOGY COMPANIES.

BATTELLE MEMORIAL INSTITUTE, OF WHICH THE COLUMBUS DIVISION IS PART, IS HEADQUARTERED IN COLUMBUS, OHIO. WE ARE THE WORLD'S LARGEST INDEPENDENT CONTRACT RESEARCH AND DEVELOPMENT ORGANIZATION, WITH A STAFF OF 7300 IN ADDITION TO THE DIVISION OF WHICH I AM

DIRECTOR, BATTELLE'S COLUMBUS OPERATIONS INCLUDE THE CORPORATE HEADQUARTERS, THE BATTELLE PROJECT MANAGEMENT DIVISION, AND TWO SUBSIDIARIES FOR LICENSING AND COMMERCIALIZING TECHNOLOGY. BATTELLE ALSO HAS RESEARCH DIVISIONS IN RICHLAND, WASHINGTON; GENEVA, SWITZERLAND; AND FRANKFURT, GERMANY.

BATTELLE'S COLUMBUS DIVISION EMPLOYS 3031 STAFF MEMBERS. OUR 1981 RESEARCH VOLUME WAS $121 MILLION, WITH MORE THAN 40 PERCENT OF THIS TOTAL FOR INDUSTRIAL SPONSORS. IN 1981, NEARLY 14 PERCENT OF BATTELLE'S INDUSTRIAL RESEARCH WAS DONE FOR OHIO-BASED COMPANIES, AND 24 PERCENT OF OUR GOVERNMENT RESEARCH WAS DONE FOR OHIO-BASED GOVERNMENT AGENCIES.

IN SPITE OF SOME DECLINE IN TOTAL STAFF DURING 1981, THE BATTELLE-COLUMBUS DIVISION HAS SHOWN GOOD GROWTH DURING THE PAST 5 YEARS. TOTAL NUMBER OF STAFF INCREASED BY 16 PERCENT; RESEARCH VOLUME BY 47 PERCENT; AND TOTAL AMOUNT OF PAYROLL DOLLARS BY 57 PERCENT.

ABOUT CONTRACT RESEARCH

AS AN ORGANIZATION WHICH CONDUCTS CONTRACT RESEARCH, BATTELLE PLAYS A VITAL ROLE. WE VIEW OURSELVES AS A "BRIDGE" BETWEEN GOVERNMENT AND INDUSTRY. OUR EXPERIENCE WITH GOVERNMENT AGENCIES PROVIDES INSIGHTS THAT CAN BE TRANSFERRED TO INDUSTRY; OUR WORK WITH INDUSTRY HELPS US BRING PRIVATE SECTOR KNOW-HOW TO GOVERNMENT.

THE CONCEPT OF CONTRACT RESEARCH WAS PIONEERED BY BATTELLE. CONTRACT RESEARCH ENABLES BOTH INDUSTRIAL ORGANIZATIONS AND

GOVERNMENT AGENCIES TO RECEIVE THE BENEFIT OF OUR CREATIVE EFFORTS IN A BROAD RANGE OF SERVICES, FOCUSED ON THEIR INDIVIDUAL NEEDS. OUR RESEARCH INCLUDES APPLIED, PROBLEM-SOLVING PROJECTS, DIRECTED TOWARD NEW PRODUCTS, MATERIALS, DEVICES AND PROCESSES, AS WELL AS FUNDAMENTAL STUDIES WHICH PROVIDE OUR CLIENTS WITH NEW KNOWLEDGE.

AS YOU ARE AWARE, 2 YEARS AGO, THERE WAS A GOOD DEAL OF INTEREST IN THE CONCEPT OF COOPERATIVE CENTERS OF GENERIC TECHNOLOGY (COGENTS), FUNDED AND MANAGED BY GOVERNMENT. IN EFFECT, SUCH CENTERS ALREADY EXIST IN THE PRIVATE SECTOR. CONTRACT RESEARCH AND DEVELOPMENT ORGANIZATIONS SUCH AS OURS, OFFER PRIVATE SECTOR MECHANISMS FOR COOPERATIVE RESEARCH AND DEVELOPMENT. THE BATTELLE APPROACH TO GENERIC RESEARCH IS SOMETHING WE ARE ALREADY DOING SUCCESSFULLY. WE CALL IT GROUP OR MULTICLIENT RESEARCH. IT IS A PROVEN METHOD OF POOLING INVESTMENTS OF SEVERAL COMPANIES IN A SINGLE STUDY OF A GENERAL, NONPROPRIETARY PROBLEM, AND DISTRIBUTING RESULTS TO PARTICIPATING COMPANIES FOR USE IN THEIR OWN PLANTS AND FACILITIES.

THIS METHOD OF RESEARCH ENABLES BATTELLE TO CONDUCT MAJOR INVESTIGATIONS WHICH FEW COMPANIES COULD ECONOMICALLY UNDERTAKE ALONE. TODAY, FOR EXAMPLE, WE ARE CONDUCTING 25 GROUP PROGRAMS, WHICH ARE SUPPORTED BY 550 COMPANIES. OUR GROUP RESEARCH IS AN ESTABLISHED PRIVATE-SECTOR MEANS OF ACCOMPLISHING THE SAME OBJECTIVE DESIRED BY COGENTS.

I WOULD LIKE TO DESCRIBE SEVERAL EXAMPLES OF GROUP RESEARCH CURRENTLY UNDERWAY AT BATTELLE. IN EACH OF THESE CASES, SOME OF THE COMPANIES ARE ALREADY USING THE TECHNOLOGY, EVEN THOUGH THE RESEARCH IS STILL UNDERWAY.

- Ceramic Shapes by Injection Molding -- BATTELLE SPECIALISTS ARE DEVELOPING APPROACHES FOR MANUFACTURERS TO USE INJECTION MOLDING EQUIPMENT, ORIGINALLY DESIGNED FOR PLASTICS, TO MAKE NEW, HIGH TEMPERATURE, DURABLE CERAMIC PARTS. THERE ARE 39 COMPANIES IN THIS PROGRAM.

- Close Tolerance Forging Process Technology-- WE ARE DEVELOPING THE NECESSARY TECHNOLOGY TO ENABLE COMPANIES TO USE AND/OR IMPROVE CLOSE TOLERANCE FORGING TECHNIQUES, AND SHARING THIS KNOWLEDGE THROUGH WORKSHOPS, MEETINGS AND TECHNICAL REPORTS. THERE ARE 36 COMPANIES IN THIS PROGRAM.

- Environmental Reactions on Materials for Electrical and Electronic Applications -- THE RESULTS OF THIS RESEARCH WILL AID COMPANIES IN DESIGNING AND OPERATING ELECTRICAL AND ELECTRONIC COMPONENTS IN ENVIRONMENTS THAT CAUSE CORROSION, OR RAPID DETERIORATION OF MATERIALS. 50 COMPANIES ARE PARTICIPATING IN THIS GROUP STUDY.

- Selection of Materials for H_2S (Hydrogen Sulfide) Service -- TWO YEARS AGO, BATTELLE INITIATED AN INTERNATIONAL GROUP PROGRAM TO ASSIST INDUSTRY IN RECOVERING OIL AND GAS FROM EXTREMELY CORROSIVE GEOLOGIC FORMATIONS. THE MATERIALS USED IN THESE OPERATIONS OFTEN FAIL OR DEGRADE, DUE TO HIGHER LEVELS OF SALTS, CORROSIVE GASES, TEMPERATURES, AND PRESSURES. BATTELLE IS DEVELOPING ENGINEERING DATA FOR GUIDELINES TO SELECT THE BEST MATERIALS, FROM THE STANDPOINT OF ENVIRONMENTAL DETERIORATION, ECONOMICS, AND SAFETY. MORE THAN 70 COMPANIES FROM AROUND THE

WORLD POOLED OVER $2 MILLION FOR THIS STUDY. A PARALLEL PROGRAM BEGAN LAST YEAR TO DEVELOP ENGINEERING DATA ON NON-METALLIC MATERIALS USED IN THE SAME OPERATIONS. 30 COMPANIES HAVE INVESTED $1 MILLION FOR THIS GROUP PROGRAM.

THE IMPLEMENTATION OF TECHNOLOGY

INNOVATION, IN THE CONTEXT OF IMPROVED PRODUCTIVITY AND COMPETITIVENESS IN THE WORLD MARKET, REALLY MEANS TRANSFER AND IMPLEMENTATION OF TECHNOLOGY--OR USE OF TECHNOLOGY TO CREATE NEW OR IMPROVED PRODUCTS OR PROCESSES. INDEPENDENT CONTRACT RESEARCH ORGANIZATIONS LIKE BATTELLE, BY THE VIRTUE OF OUR STRONG ROLE WITH GOVERNMENT AND INDUSTRY, REPRESENT HIGHLY EFFECTIVE INSTRUMENTS FOR INDUSTRIAL IMPLEMENTATION OF GOVERNMENT-SPONSORED TECHNOLOGY. WE DO NOT MERELY TRANSFER TECHNOLOGY TO INDUSTRY. WE WORK WITH INDUSTRY TO HELP IMPLEMENT TECHNOLOGY TO CREATE OR IMPROVE SPECIFIC PRODUCTS AND PROCESSES.

PERHAPS THE MOST SIGNIFICANT AND WIDELY KNOWN RESEARCH RESULT IN OUR HISTORY IS THE DEVELOPMENT OF XEROGRAPHY--THE SIMPLE AND INEXPENSIVE METHOD FOR COPYING ALL TYPES OF SUBJECT MATTER ON ANY TYPE OF PAPER. THIS PROCESS, INVENTED BY A PATENT ATTORNEY, CHESTER F. CARLSON, COMBINES ELECTROSTATICS WITH PHOTOCONDUCTIVITY. EXTENSIVE RESEARCH TO DEVELOP THE PROCESS WAS FUNDED AND CARRIED OUT AT BATTELLE, AND LED TO THE FULLY AUTOMATIC FAST DRY METHOD OF PHOTOREPRODUCTION IN USE TODAY THROUGHOUT THE WORLD.

ANOTHER EXAMPLE OF IMPLEMENTATION OF BATTELLE RESEARCH, WHICH IS CLOSE TO HOME, IS THE WOOSTER BRUSH COMPANY IN WOOSTER, OHIO.

Battelle has served in the role of Wooster Brush's research arm since 1950, when Wooster was a small business firm specializing in high-quality crafted paint brushes. Today Wooster is the world's largest manufacturer of paint brushes. Wooster has introduced a wide range of Battelle innovations over the years.

We are now involved in commercializing an innovative new development called Multi-Solid Fluidized Bed Combustion. We believe this development will help the nation increase its oil production by one-third, and have entered into a licensing agreement with the Struthers-Wells Corporation for commercializing this Battelle-developed process. In this process, high-sulfur coal is burned to generate steam. The steam is forced down old oil wells to stimulate and increase oil production. This is called "steam flooding". Existing steam flooding systems burn scarce oil to produce oil. Our system saves oil by burning coal, which is plentiful.

We have also recently entered into a licensing agreement for the Multi-Solid Fluidized Bed program with a European company--Foster-Wheeler Power Products. In this application, high-sulfur coal, coke and other waste fuels can be burned in industrial steam-boilers without harming the environment. We are investigating other general applications of this process, including oil shale and waste fuel processing, and for burning a variety of low-grade fuels to produce steam.

There are many other examples of Battelle technology making a difference in the world. Time, however, does not permit me to elaborate.

THERE IS ANOTHER POSITIVE CONTRIBUTION THAT A RESEARCH AND DEVELOPMENT ORGANIZATION MAKES IN A COMMUNITY. AND THAT OCCURS WHEN BRIGHT, INNOVATIVE STAFF MEMBERS LEAVE TO START UP THEIR OWN COMPANIES. OF COURSE, WE ARE NOT HAPPY TO LOSE THESE PEOPLE, BUT WE ARE PROUD OF THEIR CONTRIBUTIONS TOWARD THE TECHNOLOGICAL BASE IN OUR COMMUNITY. IN COLUMBUS, FOR INSTANCE, THERE ARE 8 SMALL COMPANIES ESTABLISHED BY FORMER STAFF MEMBERS. THEIR PRODUCTS INCLUDE COATING SYSTEMS, VARIOUS MATERIALS SUCH AS METALS AND FIBERS, AND LASER TECHNOLOGY. SOME OF THESE COMPANIES ARE BASED ON BATTELLE-DEVELOPED TECHNOLOGY.

WHAT ATTRACTS R&D FIRMS TO AN AREA

RESEARCH AND DEVELOPMENT ACTIVITIES ARE CHARACTERIZED BY A NUMBER OF ATTRIBUTES ATTRACTIVE TO A COMMUNITY. THESE INCLUDE: ABOVE-AVERAGE SALARIES; SKILLED PROFESSIONAL, TECHNICAL AND WHITE-COLLAR SUPPORT STAFF; NEGLIGIBLE ENERGY AND ENVIRONMENTAL IMPACTS; PRESTIGE FOR AN AREA; AND THE POTENTIAL FOR SPINNING OFF NEW MANUFACTURING, DISTRIBUTION, AND ADMINISTRATIVE FUNCTIONS. IT GOES WITHOUT SAYING, THAT IT BEHOOVES A COMMUNITY TO HAVE AN OBJECTIVE OF ATTRACTING HIGH-TECHNOLOGY FIRMS.

A RECENT STUDY BY INDUSTRIAL RESEARCH MAGAZINE EXAMINES SELECTION CRITERIA FOR RESEARCH, DEVELOPMENT, AND ENGINEERING FIRMS. INCLUDED IN THE CRITERIA WERE: AVAILABLE PROFESSIONAL-TECHNICAL STAFF; PROXIMITY TO SUPPORT STAFF; EXCELLENT TRANSPORTATION; HIGH QUALITY OF LIFE CHARACTERISTICS--INCLUDING EXCELLENT PUBLIC AND HIGHER EDUCATION; GOOD HOUSING, MEDICAL, AND RECREATION FACILITIES; LACK OF CRIME; AN AESTHETICALLY PLEASING ENVIRONMENT;

GOOD WORKER-COMMUNITY ATTITUDES; REASONABLE OPERATING COSTS; READILY AVAILABLE FACILITIES; LONG-TERM AVAILABILITY OF DEPENDABLE POWER; AND PROXIMITY TO COMPLEMENTING OPERATING UNITS. COLUMBUS HAS ALL OF THESE.

I APPLAUD THE COLUMBUS AREA CHAMBER OF COMMERCE FOR ITS ROLE IN CREATING WIDESPREAD AWARENESS OF THESE ATTRIBUTES, AND FOR ESTABLISHING A COMMITTEE WHICH IS EXAMINING WHAT CAN BE DONE TO ATTRACT INNOVATIVE, HIGH-TECHNOLOGY INDUSTRY TO COLUMBUS. I ALSO COMMEND CONGRESS ON THE RECENT PASSAGE OF THE RESEARCH AND DEVELOPMENT TAX CREDIT. THIS CREDIT, ALONG WITH ACCELERATED DEPRECIATION, SHOULD STIMULATE INDUSTRIAL RESEARCH AND DEVELOPMENT ACTIVITIES AND INNOVATION IN THE UNITED STATES.

IN THIS PRESENTATION, I HAVE DESCRIBED SOME OF THE IMPACTS OF A RESEARCH AND DEVELOPMENT ORGANIZATION, AND CHARACTERISTICS OF COMMUNITIES THAT ATTRACH HIGH-TECHNOLOGY INDUSTRY.

INNOVATION IS GOING TO BE THE KEY INGREDIENT TO OUR COUNTRY'S FUTURE, AND COMMUNITIES LIKE COLUMBUS, OHIO, WITH ITS TECHNOLOGICAL ORIENTATION, WILL PLAY A CONTINUALLY INCREASING VITAL ROLE. I APPRECIATE THE OPPORTUNITY TO DISCUSS THIS IMPORTANT ISSUE WITH YOU.

Mr. **Shamansky**. Thank you, Ed.

Mr. Elfner.

Mr. **Elfner**. Mr. Chairman, members of this distinguished committee, good morning. I am Lynn Elfner, executive officer of the Ohio Academy of Science. I appreciate the opportunity to appear before you this morning to offer my comments on local incentives for high technology firms and innovation.

My central thesis is that to harvest the fruits of science, someone has to tend the orchard.

Many changes have occurred during the Academy's history since our founding in Columbus, Ohio, in 1891. But one thing remains constant, the need to maintain and improve the climate for innovation and discovery. Nearly a century of service has earned the Academy the respect and reputation as the common meeting ground of scientific activities of the state.

In a recent book entitled, The Reindustrialization of America, the editors of Business Week conclude that a workable strategy for reindustrialization must therefore recognize two things. First, that the country's economic health is increasingly determined by invisible investments in human capital; and second, that high technology is a key element to increasing productivity and spurring economic growth.

In 1980, the Ohio Development Financing Commission published a survey of leading figures in the field of research and development in Ohio. Among the several common concerns expressed by these high technology leaders are the development and retention of personnel, and the problem of the image of Ohio as a place for highly educated people to live and raise their families. They also expressed concern about the lack of linkage between industries and universities.

At the Academy's annual meeting this April, Dr. Robert Premus, an economist for the Joint Economic Committee of Congress, will report on the results of a mail survey of over 2,000 high technology companies in the Nation. His preliminary results indicate that the cost and the availability of labor, scientific and professional, is a dominant factor in location choices. The committee's study places major focus on the role of the university system in attracting high technology companies. The study also found that traditional State and local government development tools have little effect on the growth and location choices of high technology companies.

As I said, my central thesis today is that to harvest the fruits of science, someone must tend the orchard. More eloquently than I, Pasteur has stated, "No, a thousand times no, there does not exist a category of science to which one can give the name applied science. There are science and applications of science bound together as a fruit to the tree which bears it."

Similarly, the prolific writer, Isaac Asimov, has observed,

> The fact is that science and technology are one.
>
> High-tech begins in the mind. Education and basic research are the twin supports of the high-tech revolution sweeping the nation.

These words are not mine. They are quoted from an ad by Johns Hopkins University in the premier issue of High Technology Magazine.

Closer to home, the University of Dayton says, "Advanced technology begins with thinking people."

The process of developing high technology is not much different from growing apples or producing any kind of fruit. Time and tender, loving care are needed for both. Substantive attention and hard work in the face of competing elements are required for both.

Let me give you a few examples of what we are doing. By far, the most influential of the Academy's programs is the Junior Academy which was established over three decades ago for the purpose of discovering and fostering ability in science among high school students. Science Day Programs at local, district, and State levels are promoted through a decentralized administration involving 13 college and university centers. In Columbus, Capital University serves as our center.

Since the founding of the Junior Academy, over a quarter of a million Ohio students have participated. No better mechanism has been developed to plant and nurture the seeds of high technology than the Junior Academy.

I will give you a couple very specific results. One of this Nation's most prestigious programs for young students is the Westinghouse Science Talent Search now in its 41st year. This year we had 9 students in the honors group and 3 national winners.

Appended to this testimony is an analysis of the 36 Ohio applicants. All of the 1982 honor students and all of the winners have been influenced by the Academy. Overall, 77 percent of the students from Ohio who participate have participated in our programs. Unfortunately, central Ohio is a full year or more behind other areas of Ohio in involving their students in this top-rated program. Only one student out of 36 applicants was from Columbus. Our central district center at Capital University is working hard to improve this record, and as part of our "Science For the 80's" development program, we are seeking local corporation and foundation support to reverse this trend.

Also, of note and concern to Ohio's academic and economic leaders should be the fact that the brain drain, noted on several occasions by Bill Papier of the Ohio Bureau of Employment Services, may start in high school. Statistics from 1981-82 Westinghouse Science Talent Searches show that 36 percent of these top students are headed out of State to places like Harvard, MIT, Johns Hopkins, Brown, and Notre Dame. For the economic future of Ohio, we have got to make sure they come back.

Students who participate in our programs have more than a leg up on others. They hit the college campuses at a full run while others are still sitting on a curb tying their shoes. By now you probably realize that the Ohio Academy of Science is a human capital development organization. The careers of hundreds, if not thousands, of scientists and engineers can be traced by their substantive participation in our work.

At our 91st annual meeting to be hosted on April 23-25 of this year by the Ohio State University, over 370 technical presentations will be made. That is what I mean by substantive participation. This year's meeting theme, and I wish the Congresswoman was here—this year's meeting theme is "Women in Science." And it will be highlighted by a keynote address by Nobel Laureate Dr. Rosalyn Yalow. Her work has helped spawn the whole high-tech industry of radioactive tracers.

Also, of special note are two symposia designed to improve the relations between industry and academia. One, on emerging industrial technologies, and on the area of robotics. These symposia present ways for substantive participation between industry and academia.

We are also addressing the problem of Ohio's image as a good place to live. In 1979, with the help of the Department of Natural Resources, Battelle Memorial Institute Foundation, Nationwide Insurance, the Columbus Foundation, and numerous other sponsors, we produced "Ohio's Natural Heritage." This Ohioanna Award winning book is in the hands of 17,000 people in Ohio, many other States, and several foreign countries. At least five other States are now developing similar books based on the leadership of the Ohio Academy of Science.

This week, at a Cincinnati convention, dignitaries from across the Nation will be given copies of "Ohio's Natural Heritage" to create a favorable impression of Ohio. Nationwide Insurance, one of the principal sponsors, has used hundreds of copies for this purpose, too.

Mr. William Schmitt, director of education here at COSI, is director of the American Junior Academy of Science. When Bill concluded his program at Washington, D.C., this January, he got a standing ovation from students and research leaders from nearly 20 different States. Our delegation under his leadership has made a lasting and favorable impression of Ohio on people all across this country. These education and research related activities require substantive participation for success. Hundreds of thousands of manhours of volunteer time have gone into them and as a result the development of hundreds of thousands of individuals has been enhanced and the image of Ohio improved.

Now, let me suggest some ways that you, too, can help us tend the orchard so that we all can harvest the fruits of science. First, for this committee and Congress in general, don't fight the New Federalism. Shape it; guide it to benefit the States. Insist on field hearings like this one today to make sure that the dismantling of the Federal bureaucracy does not set up larger State bureaucracies still unable to respond effectively to local problems and needs.

Second, fight for science and math education programs directed specifically at the elementary and secondary school level.

Third, a national disgrace, referred to earlier here, has developed in a proposed fiscal year 1983 budget for the National Science Foundation. Only $15 million is budgeted for science and engineering education, or 1.4 percent of the total agency projected budget of $1.0728 billion. As recently as fiscal year 1981, the NSF budget for science and engineering education was $70.7 million. The NSF reaction has been to allocate $700,000 in the fiscal year 1982, to establish an ad hoc commission on precollege education in math, science, and technology to study the problem. Not a single penny of the $700,000 will have an immediate impact on the improvement of science and engineering education in the United States.

Two years ago the NSF published eight volumes, over 2,000 pages of reports, entitled "The Status of Precollege Science, and Math, and Social Studies Education." As far as I know, the only outcome of these reports was to establish yet another study commission.

Frankly, science education at the national level is being commissioned to death. In keeping with the New Federalism, I would urge you and your congressional colleagues to carve out a few million dollars for programs available only to State and local organizations like COSI and the Ohio Academy of Science, where our local and State constituencies will make sure that the funds go to the purpose of benefiting the people directly and not for more studies. If you are interested, I can give you a detailed description of programs with proven success records.

State government. The Ohio Development Financing Commission should continue to work with the Ohio Academy of Science, university administrators, and researchers to build bridges of understanding between Government, industry, and the academic community. ODFC, in cooperation with local chambers of commerce and convention bureaus, ought to assist the Ohio Academy of Science in planning and implementing a long-range program to attract national conventions of technical organizations to Ohio and to improve the image of Ohio as a good place for high-tech people to work and live.

The Ohio Department of Education should establish a full time science education supervisor. This position has been vacant since August 1980, and will be filled at one-third time—one-third full time equivalent on July 1. Ohio's businesses, industries, and universities are being shortchanged, and should work immediately to solve this problem.

Local. The Columbus Area Chamber of Commerce should continue its leadership role in bridging the gap between industry and academia. The chamber should urge its members to make substantive contributions to the academy's efforts to expand our programs to advance the Columbus area beyond the level of participation of other parts of Ohio.

By substantive participation, I don't mean just money. I mean manpower, advice, consulting. To bring this about, the chamber and the academy could call a Science and Math Education Summit Conference to bring together leaders of business, industry, elementary and secondary education, and higher education to make Columbus an example for all of Ohio for cooperative improvement in science and math education. In 3 to 5 years time, Columbus could outpace other areas in Ohio and the Nation.

The local universities, Ohio State, Capital, Ohio Dominican, and others, should offer continuing education courses dealing with elementary or for—excuse me, for elementary and middle and high school teachers dealing with the design of student research and technical communications.

To avoid costly mistakes and to benefit from the work of others, the Columbus Area Chamber of Commerce ought to host a statewide meeting of other chambers and development related groups to share and build upon strategies for improving the climate for innovation and discovery. Included in this meeting should be leaders from the academic community.

Ohio employers, R. & D. personnel, should assist the Academy financially and organizationally to establish the Science Day Alumni

Club, or other mechanisms to attract and retain Ohio's best brains in Ohio. We need to recruit these students with the same vigor as we do our athletes.

This city has a firm economic foundation. We may not have the culture of Cleveland or other cities, but neither do we have the magnitude of the urban problems. A few years ago a local newspaper ran a contest for a city slogan. I suggested "Columbus, the City of Discovery," or some version of Dr. Sherwood Fawcett's 1975 speech to the Rotary Club, entitled "Columbus, Science City, U.S.A." In the end, slogans don't attract high technology, but they may help us in building a good image. Ultimately, high technology begins in the mind. You've got to plant the seeds early, and develop a good climate for innovation and discovery. You've got to tend the orchard to harvest the fruits of science.

Again, as Pasteur says, "In the fields of observation, chance favors only the mind that is prepared."

Thank you.

[The prepared statement of Mr. Elfner follows:]

TO HARVEST THE FRUITS OF SCIENCE SOMEONE HAS TO TEND THE ORCHARD

Statement of

Mr. Lynn Edward Elfner
Executive Officer
The Ohio Academy of Science
445 King Avenue
Columbus, Ohio 43201
Phone (614) 424-6045

before the
U.S. House of Representatives
Science and Technology Subcommittee on
Science, Research and Technology

Hearing on "Local Incentives for
High-Technology Firms and Innovation"

COSI Auditorium
Columbus, Ohio

February 16, 1982

Mr. Chairman and Members of this Distinguished Committee:

Good morning! I am Lynn Elfner, Executive Officer of The Ohio Academy of Science. I appreciate the opportunity to appear before you this morning to offer my comments on local incentives for high technology firms and innovation. My central thesis is that "to harvest the fruits of science someone has to tend the orchard."

In 1891 the promise of hearty cooperation from a goodly number of Ohio scientists sparked the establishment of The Ohio Academy of Science -- one of this nation's leading scientific organizations. Wisdom, vision and leadership have enabled the Academy to grow, serve society and influence an ever widening circle of members and friends in Ohio, many other states and in several foreign countries.

Many changes have occurred during the Academy's history, but one thing remains constant: the need to maintain and improve the climate for innovation and discovery. This climate has been remarkably aided by the persistent, enthusiastic pursuit of the Academy's objectives: to stimulate interest in the sciences, to promote research, to improve instruction in the sciences, to disseminate scientific knowledge and to recognize high achievements in attaining these objectives.

Nearly a century of service has earned the Academy the respect and reputation as the common meeting ground of the scientific activities of the state.

Writing in the recently published book entitled The Reindustrialization of America, the editors of Business Week have pointed out that the old industrial society in the United States that generated wealth in the form of capital goods and manufacturing is giving way to a different society valued more in terms of intangible assets such as knowledge and information processing. The editors also assert that the new information-based society cannot easily be gauged with the economic yardstick formulated for the old.

Vincent E. Giuliano of Arthur D. Little has observed that such industries as data processing and aerospace are really selling a "package of knowledge in hardware form." He adds, "human capital -- the investment in skills and knowledge of people -- becomes even more important, but the (economic) measures we use simply ignore the vast current rate of investment in human resources."

The Business Week editors conclude that "A workable strategy for reindustrialization must therefore recognize two things:

1) first, that the country's economic health is increasingly determined by 'invisible' investments in human capital, and
2) second, that high technology is a key element to increasing productivity and spurring economic growth."

In 1980 the Ohio Development Financing Commission published "A Survey of Leading Figures in the Field of Research and Development in Ohio." In that massive volume are the candid comments of top people at many well known Ohio companies including Battelle Memorial Institute, Goodyear Tire and Rubber Company, Goodyear Aerospace Corporation, Procter and Gamble, NCR, Cincinnati Milacron, Monsanto Research Corporation, Autech Corporation, TRW, Inc., The Charles F. Kettering Foundation, and The Ohio State University.

Among the several common concerns expressed by these high technology leaders are the development and retention of personnel and the problem of the image of Ohio as a place for highly educated people to live and raise their families. They also express concern about the lack of linkage between industries and universities.

At the Academy's Annual Meeting this April, Dr. Robert Premus, an economist with the Joint Economic Committee of Congress, will report on the results of a mail survey of over 2,000 high technology companies. His preliminary results indicate that the cost and availability of labor, scientific and professional, is the dominant factor in location choices. The traditional factors of nearness to markets and raw materials, cultural amenities, transportation, climate or energy costs are not important factors in location choices of high technology companies. The Committee's study places major focus on the role of the university system in attracting high technology companies. The study also found that traditional state and local government development tools have little effect on the growth and location choices of high technology companies.

As I said, my central thesis today is that to harvest the fruits of science someone must tend the orchard. More eloquently than I, Pasteur has stated, "No, a thousand times no; there does not exist a category of science to which one can give the name applied science. There are science and the applications of science, bound together as the fruit to the tree which bears it."

Similarly, the prolific writer Isaac Asimov has observed "The fact is that science and technology are one. Just as there is only one species of human being on Earth, and all divisions into races, cultures, and nations are but man-made ways of obscuring that fundamental truth, so there is only one scientific endeavor on Earth -- the pursuit of knowledge and understanding -- and all divisions into disciplines and levels of purity are but man-made ways of obscuring that fundamental truth.

High Tech begins in the mind. Education and basic research are the twin supports of the High Tech revolution sweeping the nation. These words are not mine. They are quoted from an ad by Johns Hopkins in the premier issue of *High Technology* magazine. Closer to home, the University of Dayton, in a recent press release announcing the receipt of a $150,000 challenge grant to prepare professionals for the demands of designing and producing advanced technology used the headline "Advanced Technology Begins With Thinking People."

If you were to go into the business of growing apples you would have to do some thinking and you wouldn't expect instant results. You would first have to pick the right location, then you would have to select and plant the seeds, and hope for the right climate. You know that the first few years are critical. An ill wind at the wrong time will spell failure. Eventually, if you tend your orchard right you'll be rewarded with the fruit. The process of developing high technology is not much different from growing apples or producing any kind of fruit. Time and tender loving care are needed for both. Substantive attention and hard work in the face of competing elements are required for both. But persistance pays off. Let me give you a few examples of how The Ohio Academy of Science is tending the orchard.

By far the most influential of the Academy's programs is the Junior Academy which was established over three decades ago for the purpose of discovering and fostering ability in science among high school students. Science day programs -- at local, district and state levels -- are promoted through a decentralized administration involving 13 college and university centers. The progressive development of science projects and the communication of results to peers are the underlying themes of most Junior Academy programs. Since the founding of the Junior Academy over a quarter of a million Ohio students have participated. No better mechanism has been developed to plant and nurture the seeds of high technology than the Junior Academy. Let me give you some specific results.

One of this nation's most prestigious programs for young students is the Westinghouse Science Talent Search. This year we had nine students in the Honors Group and three National Winners. Appended to this testimony is an analysis of the 36 Ohio applicants. All of the 1982 Honors Students and all of the Winners have been influenced by the Academy. Overall, 77% of the students have participated in our programs.

Unfortunately, Central Ohio is a full year or more behind other areas in Ohio involving their students in this top-rated program. Only one student out of the 36 applicants was from Columbus. Furthermore, at our 1981 State Science Day, only 15 students out of nearly 451 came from Central Ohio. Some individual schools in other areas of Ohio had more students than this. Our Central District Center of Capital University is working hard to improve this record. And as part of our SCIENCE FOR THE '80s DEVELOPMENT PROGRAM we are seeking local corporation and foundation support to reverse this trend.

Also of note and concern to Ohio's academic and economic leaders should be the fact that the "brain drain" noted on several occasions by William Papier, Director of Research and Statistics for the Ohio Bureau of Employment Services, may start in high school. Statistics from 1981 and 1982 Ohio-Westinghouse Science Talent Searches show that 36% of these top students are headed out-of-state to places like Harvard, M.I.T., Johns Hopkins, Brown and Notre Dame. In one sense I don't blame them. But for the economic future of Ohio we've got to make sure they come back. I don't think we even know what happens to them after college graduation. And I'm sure that most Ohio corporations are doing little, if anything, to go after them. In the past if we had been as concerned about recruiting and retaining academic talent as we have been about athletic talent, I suspect we wouldn't be meeting here today. To say that in this city will probably brand me as a heretic. But science and high technology are based on brains and not brawn.

Students who participate in our programs have more than a leg up on others. They hit the college campuses at a full run, while others are still sitting on the curb tying their shoes.

By now you probably realize that The Ohio Academy of Science is a human capital development organization. The careers of hundreds if not thousands of scientists and engineers can be traced by their substantive participation in our work. At our 91st Annual Meeting to be hosted on April 23-25, 1982, by The Ohio State University, over 370 technical presentations will be made. That's what I mean by substantive participation. Many of these reports are on the thresholds of science. I suspect that well over 100 of these will be by researchers making their "first contribution to science."

This year's meeting theme is "Women in Science" and it will be highlighted by a keynote address by Nobel Laureate Dr. Rosalyn Yalow. Her work has helped spawn the whole high tech industry of radioactive tracers.

Also of special note are two symposia designed to improve the relations between industry and academia: the first on Friday, April 23, 1982, will focus on Emerging Industrial Technologies and the second on Saturday, April 24, 1982, will address the area of Robotics. These symposia represent an unexcelled opportunity for substantive participation of industry and academia. A summary of these is appended.

Since its founding in 1900, our publication, The Ohio Journal of Science, has provided an excellent outlet for scholarly communication on a broad range of subjects. For over half a century the Journal has been used by The Ohio State University Library as a principal medium of exchang for hundreds of technical publications from over 60 foreign countries. Again, the Journal provides a way for substantive participation in the development of human resources.

We are also addressing the problem of Ohio's image as a good place to live. In 1979 with the help of The Ohio Department of Natural Resources, The Battelle Memorial Institute Foundation, Nationwide Insurance, the Columbus Foundation and numerous other sponsors, we produced Ohio's Natural Heritage book. Now in its second printing, this Ohioana Award winning book is in the hands of over 17,000 people in Ohio, many other states and several foreign countries. At least five other states are now developing similar books based on the leadership of The Ohio Academy of Science. This week at a Cincinnati convention, dignitaries from across the nation will be given copies of Ohio's Natural Heritage to create a favorable impression of Ohio. Nationwide Insurance has used hundreds of copies for this purpose, too.

Our position in technical communications has been recognized for many years. With the help of Ms. Dolores Landerman at Battelle's Columbus Laboratories, we have produced the Technical Writing Style Guide and the Proposal Guide. Both serve to enhance the image of Ohio as a state where we place emphasis on the skills of communication of technical information.

From my position on the Board of Directors of the National Association of Academies of Science I've been able to get Mr. William Schmitt, Director of Education here at COSI, into the position of Director of the American Junior Academy of Science.

When Bill concluded his program in Washington, D.C. this January he got a standing ovation from students and research leaders from nearly 20 different states. Our delegation, under his leadership, has made a lasting and favorable impression of Ohio on people all across this country.

These educational and research related activities require substantive participation for success. Hundreds of thousands of man hours of volunteer time have gone into them. And, as a result, the development of hundreds of thousands of individuals has been enhanced and the image of Ohio has been improved. Now let me suggest some ways you, too, can help us tend the orchard so that we all can harvest the fruits of science.

Recommendations

First, for this Committee and Congress in general:

- Don't fight the "New Federalism," shape it and guide it to benefit the states. Insist on field hearings, like this one today, to make sure that the dismantling of the Federal bureaucracy doesn't set up a larger state bureaucracy still unable to respond effectively to local problems and needs.
- Fight for science and math education programs directed specifically at the elementary and secondary school level; take a jaundiced view of any Federal proposals for sweeping changes in curricula. Our children don't need to be guinea pigs in experimental curricula. We need to do a better job of tapping the enormous resources already available.
- A National disgrace has developed in the proposed FY 1983 Budget of the National Science Foundation. Only $15 million is budgeted for science and engineering education or 1.4% of the total agency budget of $1.0728 billion! As recently as FY 1981 the NSF Budget For Science and Engineering Education was $70.7 million or 6.7%. The NSF reaction has been to allocate $700,000 in FY 1982 to establish an ad hoc Commission on Pre-College Education in Mathematics, Science and Technology to study the problem. Not a single penny of this $700,000 will have an immediate impact on the improvement of science and engineering education in the United States. Two years ago the NSF published eight volumes (over 2000 pages) of reports on the Status of Pre-College Science, Mathematics and Social Studies Education. As far as I know the only outcome of these reports was to establish yet another study commission. Frankly, science education at the National level is being commissioned to death. In keeping with the "New Federalism" I would urge you and your Congressional Colleagues to carve out a few million dollars for programs available only to state and local organizations like COSI and The Ohio Academy of Science where our local and

state constituencies will make sure that the funds go to the purpose of benefiting people directly and not for more studies. If you are interested, I can give you a detailed description of programs with proven records of success.

State Government

- The Ohio Development Financing Commission should continue to work with The Ohio Academy of Science, university administrators and researchers to build bridges of understanding between government, industry and the academic community. Deans of engineering, graduate schools and departmental chairmen should be called together by O.D.F.C to review O.D.F.C.'s R & D studies to focus the talent in the universities with the industrial needs identified in O.D.F.C. studies.

- O.D.F.C. in cooperation with local chambers of commerce and convention bureaus ought to assist The Ohio Academy of Science in planning and implementing a long range program to attract national conventions of technical meetings to Ohio and to improve the image of Ohio as a good place for high tech people to work and live.

- The Ohio Department of Education should establish a full time science education supervisor. This position has been been vacant since August 1980, and will be filled at a 1/3 F.T.E. on July 1, 1982. This is pure tokenism. Ohio's businesses, industries and universities are being short changed and should work immediately to solve this problem.

Local

- The Columbus Area Chamber of Commerce should continue its leadership role in bridging the gap between industry and academia. The Chamber should urge its members to make substantive contributions to the Academy's efforts to expand our programs to advance the Columbus Area beyond the level of participation of other parts of Ohio. By substantive contributions I don't mean just money; I mean, for example, that Central Ohio corporations ought to voice their needs for science and engineering personnel to public and private school officials and to trustees and administrators of institutions of higher education. Central Ohio corporations ought to adopt specific elementary and high schools and share their expertise and business perspectives. To bring this about the Chamber and the Academy could call a Science and Math Education Summit Conference to bring together leaders of business, industry, elementary and secondary education and higher education to make Columbus an example for all of Ohio for cooperative improvement in science and math education. In 3-5 years time Columbus could outpace other areas in Ohio and the Nation.

- The Ohio State University, Capital University, Ohio Dominican

College and other Central Ohio institutions should offer continuing education courses for elementary, middle and high school teachers dealing with design of student research and technical communications.

- Finally, to avoid costly mistakes and to benefit from the work of others, the Columbus Area Chamber of Commerce ought to host a statewide meeting of other chambers and development related groups to share and build upon strategies for improving the climate for innovation and discovery. Included in this meeting should be leaders from the academic community.
- Ohio employers of R&D personnel should assist the Academy financially and organizationally to establish the Science Day Alumni Club or other mechanism to track and retain Ohio's best "brains" in Ohio. We need to recruit these students with the same vigor as we do our athletes.

Now, let me end on a positive note. This city has a firm economic foundation. We may not have the culture of Cleveland or other cities, but neither do we have the magnitude of urban problems. A few years ago a local newspaper ran a contest for a city slogan. I suggested "Columbus - The City of Discovery" or some version of Dr. Sherwood Fawcett's 1975 speech to the Columbus Rotary Club: "Columbus - Science City U.S.A." In the end, slogans alone don't attract high technology but they may help in building a good image.

Ultimately, high technology begins in the mind. You've got to plant the seeds early and develop a good climate for innovation and discovery. You've got to tend the orchard to harvest the fruits of science. And, again as Pasteur says, "In the fields of observation chance favors only the mind that is prepared."

Thank you.

THE OHIO ACADEMY OF SCIENCE -- WESTINGHOUSE SCIENCE TALENT SEARCH

Analysis of 1982 Applicants

Results: Ohio had 3 of 40 National Winners and 9 of 300 in Honors Group out of a total of 950 applicants nationally. All three Ohio students will receive $500 scholarships, an all-expense paid trip to Washington, D. C. and a chance to win a $12,000 scholarship.

Name	High School	City	College Choice	Field of Study	Career Influence	Academy Involvement	Comments
Alice Chen	Harvey Firestone	Akron	undecided	bio. sciences	Peter Chen, brother	science days	Honors 1982
Carrie Rinker	Waterloo	Atwater	U. C.	molecular bio.	Richard Depew, NEOUCM	see attached note	Honors 1982
Lisa Palumbo	Northwest	Cincinnati	U. D.	chemistry	David Jones, sci. teacher	science days	2nd in class of 411
Karen Dollries	Oak Hills	Cincinnati	U. C.	physical chem.	Rebecca Stricklin, sci. teacher	science days	Westinghouse Winner 1982
Therese Peter	Oak Hills	Cincinnati	U. C.	biochemistry	David Peter, brother	science days	Top 5% of class of 794
Maryann Winstel	Oak Hills	Cincinnati	U. C.	electrochem.	Rebecca Stricklin, sci. teacher	science days	Honors 1982
Susan Conte	Maranatha Christian	Columbus	Capitol U.	physical sci.	Gerald Penn, Lab Dir.	science days	1st in class of 22
Daniel Ebert	Carroll	Dayton	U.S. Air Force Academy	biomed. engin.	Thomas Weeks, Lab. Dir.	science days	5th in class of 270
Michael Martino	Carroll	Dayton	U. D.	physics	Joseph Martino, father	science days	35th in class of 270
Thomas Whitney	Carroll	Dayton	O. S. U.	physics	James Whitney, father	science days	1st in class of 270
Edward Pritchard	Fostoria	Fostoria	O. S. U.	water quality	Muriel Paananen, sci. teacher	unknown	3rd in class of 193
Hugh Moody	Hudson	Hudson	Purdue	botany	Ronald Koroly, sci. tea.	unknown	top 25% in class of 303

Name	High School	City	College Choice	Field of Study	Career Influence	Academy Involvement	Comments
Shigeyoshi Moroi	Theo. Roosevelt	Kent	Yale	bio. & physics	David Moroi, father	science days	top 10% in class of 332
Mitchell Tsai	Theo. Roosevelt	Kent	M. I. T.	physics	Jon Secaur, sci. teacher	science days	Westinghouse Winner 1982
Patrick Cronley	Marion Catholic	Marion	U. D.	behavioral Sci.	Sr. Virginia Scherer, sci. teacher	science days	4th in class of 49
Joseph Morman	Marion Catholic	Marion	U. D.	physics	Sr. Virginia Scherer, sci. teacher	science days	2nd in class of 49
Paula Scharf	Marion Catholic	Marion	O. S. U.	botany	Sr. Virginia Scherer, sci. teacher	science days	10th in class of 49
Eric J. Sachs	Midpark	Middleburg Hts.	Harvard U.	organic chem.	Geo. Ritter, industrial chemist	unknown	top 5% in class of 531
Warren Luhrs	Lake	Millbury	Oh. Northern U.	physics	Carl Luhrs, father	science days	top 25% in class of 173
Sidney Hastings	West Holmes	Millersburg	College of Wooster	elec. engin.	Thomas McMillen, sci. teacher	science days	top 10% in class of 200
James Kasner	West Holmes	Millersburg	Akron U.	physics	Thomas McMillen, sci. teacher	science days, AJAS	Honors 1982
Lucinda Gibson	New Philadelphia	New Philadelphia	E. Kentucky U.	occupational therapy	Gordon Stauffer, sci. teacher	unknown	top 10% in class of 324
Andrew Peterson	Tolawanda	Oxford	Miami	ornithology	David Osborn, prof.	Academy member	top 5% in class of 301
Pete Papatheodorou	Parma	Parma	M. I. T.	physics	Darlene Davies, sci. teacher	science days	3rd in class of 671

Westinghouse Science Talent Search
Page 3

Name	High School	City	College Choice	Field of Study	Career Influence	Academy Involvement	Comments
Karl Krauss	Valley Forge	Parma Hts.	Case W. R. U.	physics	John Shockcor, industrial	unknown	8th in class of 651
Helen Mayer	Valley Forge	Parma Hts.	Case W. R. U.	biology	Annajean Slater, sci. teacher	unknown	1st in class of 651
Judith Barlage	Russia Local	Russia	U. C.	water pollution	Edward Vincent, sci. teacher	unknown	1st in class
Kelly McAleese	Black River	Sullivan	Case W. R. U.	engineering	Norman Dria, sci. teacher	see attached note	Westinghouse Winner 1982
Brian Higgins	St. John's	Toledo	St. Joseph's U.	chem. engin.	Father Sweeny, sci. teacher	science days	14th in class of 248
Mark Knox	St. John's	Toledo	Georgetown U.	chemistry	Thomas Knox, father	member, sci. days	Honors 1982
Thomas Povsic	St. John's	Toledo	Harvard U.	electrochem.	Father Sweeny, sci. teacher	sci. days, AJAS	Honors 1982
Peter Wiley	St. John's	Toledo	Notre Dame	biology	Father Sweeny, sci. teacher	science days	17th in class of 248
Christine Cigolle	Lake Local	Uniontown	Akron U.	biochemistry	Mary Ellenburger sci. teacher	science days	1st in class of 280
William Guilford	Wauseon	Wauseon	St. Francis College	medicine	James Guilford, brother	research grant, science days	21st in class of 148
Roxanne Jaros	Twin Valley	W. Alexandria	O. S. U.	biology	Stephen James, gov't. lab tech.	science days	top 25% in class of 114
Lisa Joseph	Zanesville Rosecrans	Zanesville	Notre Dame	genetics	Janice Drake, lab tech.	unknown	top 10% in class of 80

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WINNER 1982

PERSONAL DATA BLANK

To be filled in by Student, Teachers and Principal

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Annual Science Talent Search

Conducted by Science Service, Inc. for the
WESTINGHOUSE SCIENCE SCHOLARSHIPS AND AWARDS

Full Legal Name: (PRINT IN CAPITAL LETTERS) McAleese (last name), Kelly (first name), Ann (middle name)

Address: 47149 Bursley Road (street and number), Wellington (city), Ohio (state) 44090 (zip code)

Name of School: Black River High School. Address of School: Sullivan (city) Ohio (state) 44880 (zip code)

Age at Last Birthday: 17 Date of Birth: 6 (month), 23 (day), 64 (year) Sex: Female (male or female)

Place of Birth: Cleveland (city), Ohio (state or foreign country)

Title of Project Report: Developments for High Performance Hot Air Solar Collector Systems Using Flat Bed and Evacuated Tube Prototypes

Scientific Field of Project Report: Engineering (solar energy design)

The PERSONAL DATA BLANK has been designed to show, for each participant in the Annual Science Talent Search, the evidences of those traits, characteristics, attitudes, and habits which are an important part of becoming a creative scientist. Because these evidences are important, both the student and his teacher must be sure that the information requested is given fully and completely.

The PERSONAL DATA BLANK should be completed as soon as possible after it is received by the high school.

The PERSONAL DATA BLANK has four parts. Part I must be filled out by the STUDENT himself. This should be done as soon as possible after the blanks have been received, and should be reviewed by the teacher to see that the information is complete.

Part II will be filled out by the STUDENT, and then reviewed by the TEACHER who will add any further information which may be pertinent. Directions must be followed carefully, giving full information.

Part III will be filled out entirely by the teacher immediately after the student has completed Parts I and II.

Part IV is to be filled out by the High School Principal.

TEACHERS and STUDENTS must follow the instructions for each Part, so that the information given will be maximally useful in selecting those who are to be awarded honors, and so that no one will be dropped from further consideration because of lack of requi information.

PART I *(To be filled out by the student)*

What college or professional school do you expect to attend?

Case Western Reserve University
University Circle
Cleveland, Ohio 44106
name and address of college

What course of study do you plan to follow in college or professional school?

Pre-medical or engineering curriculum with emphasis on bio-engineering field then into specialization

What occupation do you actually expect to follow?

First Choice Health-medicine
Second Choice Bio-engineering

If you could do just as you please, what would you really like to be doing ten or fifteen years from now? Why?

I am challenged & satisfied by the seeking of the goals, not the goals I seek, to maintain diversification, creating a larger perspective to examine my world, making my mark by leaving something of benefit behind.

What foreign languages do you read readily?

German

What studies in high school have you liked least?

Education is a 24-hour process; can't say I disliked any learning, only stagnancy.

What studies in high school have you liked most?

English, science, mathematics; computer science, trigonometry, modern analysis, creative writing, literature.

CHECK HERE the *extra-class activities* (outside the classroom) in which you have participated, and the *organizations* to which you have belonged:

Formerly	Now	
X	X	Ohio Academy of Sc. youth delegate
X	X	A Science Club (4 yrs.)
X	X	A Mathematics Club: JETS team(2yr)
X	X	An Engineering Club : Am. Chem. Soc
X	X	Junior Academy of Science (2 yrs.)
X	X	A Science Fair (20 total)
X	X	Summer Science Study (3 yrs.)
X	X	Nat. Honor Soc. - President
X	X	College Club
X	X	Teachers' aid-elementary
X	X	Hospital volunteer
X	X	4-H Club
X	X	Other (specify) Amer. Ass. for the Advancement of Sc.
X	X	German Club
X	X	School Publications (Editor)
X	X	Music (specify) Band, vocal choir
X	X	Athletics (specify) Cheerleading,
X	X	track, gymnastics, intra-
X	X	murals, Pep Club
X	X	County Leadership Club
X	X	Arthritis Foundation
X	X	Vet Science Club
	X	Jr. Fair Board Council

LIST HERE *special recognitions, awards, honors, and scholarships* (e.g., valedictorian, honors in state scholarship contests, National Merit Semi-Finalist, National Honor Society, Beta Club, medals, presidencies, athletic awards, science fair honors, etc.) If additional space is needed, attach separate sheet.

National delegate Junior Science & Humanities Symposium (speaker), West Point, N.
National Youth Science Camp delegate, W. Virginia; national winner Washington, D.C. Rural Youth Tour; Governors' award from Ohio, Texas, West Virginia; (please see attached sheets for additional listing due to space limitation)

LIST HERE the *hobbies* in which you have engaged since entering secondary school (e.g., photography, aviation, cryptanalysis, etc.)

Photography (macro- and nature), creative writing, painting, acting, hiking, spelunking, lab experimentation, maintaining & breeding mammals, reptiles, & fowl, showing dogs, raising, training seeing-eye dogs for the blind, horseback riding, conservation projects (state, county), teach youth clinics, pediatric work.

What have you learned from your STS Project Report?

Basic solar principles of insolation & radiation; development of high performanc engineering systems (hot air & liquid); refining of scientific methods for engineering feasibility studies; technique to maximize heat transfer from radiation to the air & minimizing heat losses due t convection, conduction, and radiation; specific construction according to thermal output needed & design sophistication desired; utilizing basic engineering concepts to test through models; adapting functional materials to produce innovative solutions; improvement of intuitive thinking; increased mathematical skills; the formulation of procedures, methods which are successful; revamping when a 'lemon' is produced; perseverance & durability; lateral thinking concepts.

What have you done during the summers while you have been in high school?

University Hospitals- research, Ohio University teaching staff!
Last Summer: National Youth Science Camp;
Martin Essex School for the Gifte
Two Summers ago: Oberlin College faculty study;
4-H summer camp counseling;
Three Summers ago: Oberlin College faculty study;
4-H Ohio Club Congress; hospital volunteering; raising, training seeing-eye dog
Ohio Conservation Camp; International
Science & Engineering Fair; metropark

Page 2

Academic Achievements and Awards (continued)

Kelly McAleese

1. Ohio Department of Education commendation as top Ohio female science student
2. State delegate to Martin Essex School for the Gifted (school newspaper editor)
3. National delegate to National 4-H Club Congress, Chiacgo
4. Ohio University Summer Youth Trials teaching staff
5. State winner Ohio Junior Science & Humanities Symposium
6. Owens-Illinois state winner- student research (2 years)
7. Goodyear Aerospace state winner for student research (2 years)
8. Recipient of research grant (3 years) for independent arthritis studies
9. Ohio delegate to International Science & Engineering Fair, San Antonio
10. 4- U.S. Army silver and bronze science medallions
11. U.S. Navy 'Science Cruiser' Award program national finalist (2 years)
12. U.S. Navy Science Award (2 years)
13. Elected to national 'Order of the Spindletop' honorary academic societ
14. State winner Ohio Veterinary Association trophy award
15. State delegate to Hugh O'Brien Youth Leadership Conference
16. State delegate (also education housebill debater) Ohio 4-H Club Congress, Ohio State University & Ohio State Senate
17. National delegate speaker to American Association for the Advancement of Science convention, Washington, D.C.
18. Selected for summer independent-study program at Oberlin College with faculty (2 years)
19. Selected as a member of arthritis research team at University Hospitals- summer (under Dr. Roland Moskowitz, rheumatologist)
20. Medina County Student-of-the-Year award
21. Cleveland Academy of Pharmacy award- outstanding student research
22. Grand prize winner Northeast Ohio Science and Engineering Fair
23. National 1st place winner Sciquest Magazine essay competition
24. Research abstracts published in Ohio Journal of Science (3 years)
25. Ohio Academy of Science 'outstanding student of year' award
26. Speaking delegate to several university lectures, symposia, and seminars concerning my physical and biological research projects- Ohio State University, Kent State University, Heidelberg 'COSI' Conference, Wooster Ohio Academy of Science Annual Meeting (3 yrs.), Ohio University, Ohio Junior Science & Humanities Symposium (2 yrs.), Central Ohio Jr. Science Symposia (2), Akron Technical Conference, NASA's American Institute of Aeronautics & Astronautics, Cleveland Technical Societies Council.
27. Winner Bausch-Lomb mathematics- science award
28. Elected Ohio Academy of Science district youth representative
29. Lorain County Arthritis Foundation Youth Chairman
30. Selected for MARS program to Northeast Ohio Medical School 10- week medical seminar
31. Featured in America's Outstanding Names and Faces (3 years)
32. Featured in Who's Who in American High Schools
33. State winner Upjohn Company Veterinary Science 4-H competition
34. Winner Ashland College's annual earth-science trophy award (3 years)
35. Winner American Chemical Society student science award
36. Winner American Institute of Chemical Engineers award
37. Kodak Company award for outstanding use of scientific photography

38. State finalist Bowling Green State University philosophy essay competition
39. East Ohio Gas award for science research
40. U.S Air Force commendation student award (2 years)
41. Award winner of state, regional, and local Science Fairs (total of 20
42. Team member to JETS Scholastic Competition (2 years)
43. Elected member Ohio Junior Academy of Science
44. State winner Upjohn Company Veterinary Science bond award
45. Selected for summer veterinary apprentice volunteer work
46. Bahama Island "Walk-About' independent-study experience

School Achievements and Awards

1. President- National Honor Society
2. Winner 'Voice of Democracy' contest: also 4th place in district competition
3. County winner 'Law Day' essay competition
4. President of Band: Student and Director; Squad Leader: top sophomor & junior high-point band member
5. Editor- high school newspaper 'The Post'
6. Cheerleader (4 years)
7. Vice-President Science Club: also Secretary, 1980-81
8. Elected to Beta Club
9. School delegate to 25 college science or physics seminars, workshops
10. School delegate to State Scholastic Tests (biology, chemistry, Englis
11. Teachers' elementary school aid
12. National winner Guideposts Magazine essay contest
13. School commendations for science projects (3 years), Science Fairs, and science activity participation
14. Elected Grand Marshall for Commencement 1980 Exercises
15. 1st chair trumpet position (3 years in Band)
16. Nominated Homecoming Queen Candidate
17. 1981-82 Class Officer- Treasurer
18. School winner and state entrant Shell Oil Corporation Century III Leadership Competition- one of top ten state finalists
19. Selected member All-Ohio State Fair Band
20. 'Superior' ratings in OMEA state, area, and local music competitions (4 years)
21. All-Star County Band (2 years)
22. Selected for County Honor Band
23. All-Star County Jazz Band (3 years)
24. Firelands Conference Band Member (3 years)
25. Poetry published by Greater National Society of Poets

Community Achievements and Awards

1. Selected for state poetry, creative writing competition in rhymed verse and creative writing
2. County winner in 4-H interior design
3. State delegate in 4-H interior design competition
4. Best of Show County air floral design
5. 2nd place open class painting (watercolor divisions)
6. 1st awards in open photography shows

7. Lions Club service award plaque
8. American Kennel Club service medallion award
9. Selected for raising and training seeing-eye dogs for the blind
10. Selected as Oberlin Hospital patient care volunteer
11. State delegate to Ohio State 4-H Club Congress
12. State winner Bob Evans Conservation trophy award (4 years)
13. State winner Kodak Company Photography award
14. Selected for Kodak Company National Photography Exhibition
15. State delegate for Ohio Conservation Camp (official photographer)
16. State winner James A. Chapman photography trophy award
17. State winner Ohio Association of Trustees & Clerks trophy award
18. Ohio State Fair 4-H Food & Nutrition winner
19. Ohio State Fair 4-H Conservation trophy winner (4 years)
20. County 4-H Program: medallions in Leadership, Conservation, Dog Obedience, Public Speaking, Photography, Food & Nutrition, Interior Design (18 total)
21. Guest speaker rural electric cooperative annual meeting
22. Westfield Insurance Company district speaking delegate
23. Ohio State Fair 4-H Energy Awareness Conservation Chairman
24. Selected 4-H summer camp counselor
25. Selected as county 4-H county 'key leader'- assist county 4-H clubs
26. Delegate to County Leadership Club
27. County delegate to 4-H Dog Council
28. County delegate to Junior Fair Board Council
29 Winner 4-H state & county public speaking competitions (total 8 winning events)
30. County children's health campaign chairman
31. Chosen county park system summer naturalist staff member
32. Selected metroparks water testing program volunteer
33 National 4-H Week Promotion Chairman
34. Best county 4-H photograohy project (4 years)
35. Best county Food and Nutrition project
36. Area winner of American Institute of Cooperation National Conference
37. Area winner of 4-H National Founder's Camp
38. 4-H Club President (4 yrs.), Secretary (2 yrs.), Treasurer (2 yrs.), Publicity Chairman, Activity Chairman, 9-year member
39. 4-H District Summer Camp Council delegate
40. Lorain County Fair competitions- 20 various animal trophies and 45 special awards

HONORS 1982

Carrie [redacted]
6226 Waterloo Rd. Box 338
Atwater, OH 44201

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PERSONAL DATA BLANK

To be filled in by Student, Teachers and Principal

Annual
Science Talent Search

Conducted by Science Service, Inc. for the
WESTINGHOUSE SCIENCE SCHOLARSHIPS AND AWARDS

Full Legal Name: (PRINT IN CAPITAL LETTERS) RINKEL (last name), CARRIE (first name), WINIFRED (middle name)

Address: 6226 Waterloo Rd. (Box 338) (street and number), Atwater (city), OH (state) 44201 (zip code)

Name of School: Waterloo High School   Address of School: Atwater (city) OH (state) 44201 (zip code)

Age at Last Birthday: 17   Date of Birth: March (month), 26 (day), 1964 (year)   Sex: Female (male or female)

Place of Birth: Ravenna (city), Ohio (state or foreign country)

Title of Project Report: "Construction and Characterization of Δ(topA cysB) Donor Strains"

Scientific Field of Project Report: Molecular Biology (Genetics)

The PERSONAL DATA BLANK has been designed to show, for each participant in the Annual Science Talent Search, the evidences of those traits, characteristics, attitudes, and habits which are an important part of becoming a creative scientist. Because these evidences are important, both the student and his teacher must be sure that the information requested is given fully and completely.

The PERSONAL DATA BLANK should be completed as soon as possible after it is received by the high school.

The PERSONAL DATA BLANK has four parts. Part I must be filled out by the STUDENT himself. This should be done as soon as possible after the blanks have been received, and should be reviewed by the teacher to see that the information is complete.

Part II will be filled out by the STUDENT, and then reviewed by the TEACHER who will add any further information which may be pertinent. Directions must be followed carefully, giving full information.

Part III will be filled out entirely by the teacher immediately after the student has completed Parts I and II.

Part IV is to be filled out by the High School Principal.

TEACHERS and STUDENTS must follow the instructions for each Part, so that the information given will be maximally useful in selecting those who are to be awarded honors, and so that no one will be dropped from further consideration because of lack of required information.

PART I *(To be filled out by the student)*

What college or professional school do you expect to attend?

University of Cincinnati

Cincinnati, OH

name and address of college

What course of study do you plan to follow in college or professional school?

Undergraduate - Chemistry

Graduate - Biochemistry

What occupation do you actually expect to follow?

First Choice Researcher, PhD

Second Choice Doctor, MD

If you could do just as you please, what would you really like to be doing ten or fifteen years from now? Why?

I would like to be conducting research either in an academic or industrial setting. I find research rewarding.

What foreign languages do you read readily?

German

What studies in high school have you liked *least?*

Physical Education, Mythology

What studies in high school have you liked *most?*

Chemistry, Biophysiology, Literature, Calculus, Composition and Drafting

CHECK HERE the *extra-class activities* (outside the classroom) in which you have participated, and the *organizations* to which you have belonged:

Formerly	*Now*	
x		A Science Club
x		A Mathematics Club
		An Engineering Club
	X	Junior Academy of Science
	X	A Science Fair
X		Summer Science Institute
		Boy Scouts (give rank)
		Future Scientists of America
		Girl Scouts (give rank)
		Campfire Girls
	X	4-H Club
x		Other (specify) Drama club, JSHS
		Student council
X		School Publications
x		Music (specify) Music @ college
x		Athletics (specify) basketball,
		team and intramurals
	x	yearbook

LIST HERE *special recognitions*, awards, honors, and scholarships (e.g., valedictorian, honors in state scholarship contests, National Merit Semi-Finalist, National Honor Society, Beta Club, medals, presidencies, athletic awards, science fair honors, etc.) If additional space is needed, attach separate sheet.

see attached sheet (1)

LIST HERE the *hobbies* in which you have engaged since entering secondary school (e.g., photography, aviation, cryptanalysis, etc.)

sewing, piano, calligraphy, graphics, jujitsu, weight lifting, art, and writing

What have you learned from your STS Project Report?

From this project I have learned how important, yet, frustrating daily lab work can be. I have also learned to apply the knowledge I gained through various chemistry and biology courses I have taken. Most important is that I have learned that although research can be trying at times, there is nothing that I find more rewarding, or would rather spend my time doing.

What have you done during the summers while you have been in high school?

Last Summer: employed by the North Eastern Ohio College Of Medicine as a researcher

Two Summers ago: Attended an NSF summer program

Three Summers ago: Employed by Atwater Strong Co.

Carrie Rinker
6226 Waterloo Rd. Box 338
Atwater, OH 44201

SPECIAL RECOGNITIONS

1981: Superior rating, special-advanced area, Portage County Science Fair
Best of special-advanced area, Portage County Science Fair
Best of show, Portage County Science Fair
Award: American Society for Quality Control
Superior rating, special-advanced area District 5 Science Fair
Superior rating, special-advanced area Ohio State Science Day
Selection of paper to Ohio Junior Science and Humanities Symposium (JSHS)
Selection as Alternate to National Junior Science and Humanities Symposium
Selection of paper to Ohio Junior Academy of Science Meeting
Selection to represent Ohio at the American Association for the Advancement of Science meeting in January 1982
Election to Chairman of the J.S.H.S. Student Board
Appointment to Vice-President of the Ohio Junior Academy of Science
Selection by Governor Rhodes as alternate to the National Youth Science Camp
Appointment to the Ohio Women in Science Committee
Honorable Mention in the Buhl Planetarium Science Fair
Publication of Abstract (Ohio Journal of Science April 81, Science in press) "Glucocordicoid Effects on Iron Induced Spinal Cord Lipid Peroxidation"
Publication of story (fiction) in the National Beta Club Journal "My Eternal Friend"
Induction into National Honor Society
Student council representative
Secretary of Beta Club
Honorable Mention in the Ohio Tests of Scholastic Achievement; KSU District English Eleven
Third Place in the Voice of Democracy Contest

1980: Superior rating, special advanced area, Portage County Science Fair
Best of special-advanced area, Portage County Science Fair
Best of show, Portage County Science Fair
Award: American Society for Quality Control
Election as Vice President-Elect of the Junior Academy of Science
Elected as President of the Northeastern Ohio Math Science League
Selection of paper to Ohio Junior Academy of Science Meeting
Selection to speak at the Northeast Ohio Chemical Engineering Meeting
Selection to speak at the Northeast Ohio Junior Science and Humanities Presymposium
Selection for Summer Science Training Program at Purdue University
Election to 4-H Club Congress
Election to 4-H Fashion Board
Appointment to 4-H Advisory Board
Election to Student Council

Carrie Ribber
6226 Waterloo Rd. Box 338
Atwater, OH 44201

1979: Superior rating health-science area, Portage County Science Fair
Best of health-science area, Portage County Science Fair
Superior rating, health-science area, District 5 Science Fair
Superior rating, health-science area, State Science Fair
Superior rating in piano at State Solo and Ensemble Competition
Induction into Beta Club
7 first place entries in 4-H
First place in 4-H fashion competition
Alternate to State 4-h fashion competition
Induction into 4-H Champions Class
Induction into 4-H Junior Leaders
Honorable mention 4-H Safety Speaking Contest

7 5

SURVEY OF SCIENCE TALENT SEARCH WINNERS

The Science Talent Search is a program which identifies high school seniors in the United States talented in science, mathematics and engineering.

Greatest emphasis in the selection is placed on evaluation by scientists of an independent research project done by the student, and secondarily on answers to open-ended questions designed to elicit evidence of the students' interest and creativity in science, and on test scores and grades.

Forty winners are chosen among 300 Honorable Mentions, who in turn are selected from the total entry pool. The forty receive an all-expense-paid trip to Washington to compete for the scholarships and awards presented by the program.

The program is administered by Science Service, and has been supported since its inception by Westinghouse.

The following reports the results of a mail survey of the Winners of the Science Talent Search from 1942 to 1979 (38 years).

Returns

1520 Winners

1431 Questionnaires Mailed

930 Responses (64.9%)

The 89 Winners not mailed questionnaires were deceased, no known address, etc.

Degrees Earned

B.S. or higher	99%
Ph.D. or M.D.	70%

Degrees Earned is based on the number of Winners estimated to be eligible for such degrees.

Present Employment

College or University	43%
Industry	25%
Medicine	12%
Government	7%
Other - non-science	7%
Other - science related	6%

Only one former winner is working for Westinghouse.

Did Winning Help You Get Into The College of Your Choice?

Yes	56%
Probably	13%

Should the Science Talent Search Be Continued?

Yes	94%
No-Maybe	6%

Suggestions for Improvement

Keep as is	33%
More promotion	13%
Not familiar with present program	9%
Increase scholarships	2%
No reply	39%

For Those With Ph.D., Where Degree Was Obtained

Harvard	17%
Princeton	8%
MIT	7%

Berkeley	6%
Cal Tech	5%
Yale	4%
Univ. of Chicago	4%
Stanford	4%
Columbia	3%
Univ. of Wisconsin	3%
Univ. of Illinois	3%
Cornell	2%

For Those with M.D., Where Degree Was Obtained

Harvard	14%
Yale	12%
Columbia	7%

Major Honors

Ben R. Mottelson	STS-44	Nobel Prize (Physics)	1975
Leon Cooper	STS-47	Nobel Prize (Physics)	1972
Walter Gilbert	STS-49	Albert Lasker Basic Medical Research Award Nobel Prize (Chemistry)	1979 1980
Paul J. Cohen	STS-50	Fields Medal (Mathematics)	1966
Sheldon L. Glashow	STS-50	Nobel Prize (Physics)	1979
David B. Mumford	STS-53	Fields Medal (Mathematics)	1974
Roald Hoffmann	STS-55	Nobel Prize (Chemistry)	1981

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Science Service, 1719 N Street, N.W., Washington, D.C. 20036

November 1981

SYMPOSIA

91st Annual Meeting
The Ohio Academy of Science
April 23-25, 1982
Hosted by The Ohio State University

Friday April 23, 1982

EMERGING INDUSTRIAL TECHNOLOGIES AND THEIR ECONOMIC IMPACT

Arranged by Dr. Herman J. Eichel, President of Adria Laboratories, Inc. and Vice President for Economics of The Ohio Academy of Science

HIGH TECHNOLOGY INDUSTRIES AND ECONOMIC DEVELOPMENT. Dr. Robert Premus, Economist, Joint Economic Committee, U. S. Congress, 359 House Annex 2, 3rd & D. Streets, SW, Washington, DC 20515.

IMPACT OF TECHNOLOGY -- ALTERNATIVE STRATEGIES. Jules J. Duga, Ph.D., Principal Researcher, Resource Management & Economic Analyses Department. Battelle Columbus Division. 505 King Avenue, Columbus, Ohio 43201.

STRATEGIC PLANNING OF TECHNOLOGY TRANSFER. Warren H. Groff, Vice President for Academic Affairs, North Central Technical College, 2441 Kenwood Circle, Mansfield, Ohio 44901.

STRATEGY FOR ACCELERATING R & D ACTIVITY. Tom Walker; Director, Ohio Development Financing Commission. 30 E. Broad St., Columbus, Ohio 43216.

DEVELOPING A COMMUNITY'S HIGH TECHNOLOGY RESOURCE BASE: THE DAYTON CASE. John B. Cordrey, Dayton Development Council, 1940 Winters Bank Tower, Dayton, Ohio 45423.

FINANCING EMERGING TECHNOLOGY. Barry Winslow, Senior Vice President, Huntington National Bank, P.O. Box 1054, Cincinnati, Ohio 45202.

Saturday April 24, 1982

ROBOTICS

Arranged by Dr. Russell A. Primrose, Dean, School of Engineering of the University of Dayton and Vice President for Engineering of The Ohio Academy of Science

THE INDUSTRIAL ROBOT AS TRANSFER DEVICE. Vernon L. Mangold, President, KOHOL Systems, Inc., P.O. Box 1185, Dayton, Ohio 45401.

DESIGN OF A PORTABLE INSTRUMENTATION ROBOT FOR AUTOMATING ACOUSTIC INTENSITY ANALYSIS. John Coy, Ivan Morse, Dave Stephens, Will Atherton and Patrick Flanagan, The University of Cincinnati, Dept. of Mechanical and Industrial Engineering, Mail Location 72, Cincinnati, Ohio 45221.

SOME ROBOTICS DESIGN SOLUTIONS ARE SUGGESTED BY BIOLOGICAL MODELS. Dr. Dana B. Rogers, Box 24268, Dayton, Ohio 45424.

DESIGN OF A COMPUTER-CONTROLLED INDUSTRIAL ROBOT FOR MAXIMUM APPLICATION FLEXIBILITY. Ronald L. Tarvin, Research Associate, Robot Research, Dept. 03E, Cincinnati Milacron, Inc., 4701 Marburg Avenue, Cincinnati, Ohio 45209.

THE NORDSON ROBOT SYSTEM. Ernie Fena, Technical Training Manager, Robotics Division, Nordson Corporation, 4937 Mills Industrial Park, North Ridgeville, Ohio 44039.

THE IMPACT OF ROBOTICS UPON EDUCATION. Dr. Russell A. Primrose, Dean, School of Engineering, University of Dayton, Dayton, Ohio 45469.

Mr. **Shamansky**. Thank you, Mr. Elfner. Dr. Ungar, you raised, it seemed to me, a difficult point for Battelle, in which you mentioned those former associates of Battelle who are now off on their own. What is the attitude of Battelle? It seemed to set up a conflict. You don't want them to leave, but you want to encourage them. How do you handle that?

Mr. **Ungar**. Well,—— [Laughter.]

Mr. **Shamansky**. Those are the people who have already left? [Laughter.]

Mr. **Ungar**. There's a couple out here.

Basically, we are a high technology organization, and we try to put a high value on the relative freedom of our staff to, in effect, roam the technological communities in which they live, and to roam in the industries in which they work. We hope that we satisfy their needs and their professional needs within our organization, but there are times when they don't. And when they don't, we wish them good luck.

Mr. **Shamansky**. Do you tell them about Chuck James?

Mr. **Ungar**. In some instances they might fit with a need that Chuck might have, and these people invariably stop off in Chuck's office on the way out.

If what they are offering fits with what Chuck thinks he is—match his criteria, we have no inhibition against putting that combination together.

Mr. **Shamansky**. Chairman Walgren.

Mr. **Walgren**. Thank you, Chairman Shamansky.

I want to underscore the testimony of Mr. Elfner on the National Science Foundation. With respect to studies, if you go back to the time when the National Science Foundation was spending almost 7 percent of its budget on education programs, science and engineering education, in that time was there a preponderance of studies, in your view, from that budget component?

Mr. **Elfner**. If I look back 15 years ago, when I—well, 20 years ago, when I was in high school, I graduated in 1962, I was a product of the Ohio Academy of Science, and very specifically had impact from NSF funds for people who were part of what was called a "Visiting Scientists Program." These people came to the schools—industry people, business people, academia. So, that impacted directly on local schools.

Following that, while I was in college and followed the work of the Ohio Academy of Science, the Academy had the largest State program of the Nation using NSF funds at the local level for science education, specifically tailored and available only to science academies in the States.

There were a number of other areas—undergraduate research improvement was another major program. There were studies, but when you look at the amount of money being budgeted at this point in NSF for science education, it is ludicrous to spend another $700,000 on another study. The trends there are available. The data are available. There is more data than anybody needs at this point.

Mr. **Walgren**. The sad thing is that that study is really simply a defensive reaction to zeroing out the function.

Mr. **Elfner**. Right, right.

Mr. Walgren. The weight of the evidence—and this is what is so difficult about the Federal level these days—shows that we are really involved in zeroing out a whole bunch of functions. It is difficult for the public to catch up to that because the President is still on the television saying that we are not really decreasing the size of Government, we are just reducing the rate of increase.

Because of the shifting that goes on within the agencies as a philosophy of Government is imposed on an agency, and because of a large increase in the defense function, there are whole areas that are eliminated. And this is the kind of reaction you get when someone has to defend an elimination that is not truly defensible to the best of our judgment. I mean the broad-based consensus, to the best judgment, that is not defensible.

Well, I certainly think that your testimony on the National Science Foundation, in particular, the role of education, and the science education component of that is right on target. And I appreciate hearing that very much.

Mr. Elfner. I appreciate your comments.

Mr. Shamansky. Congressman Ertel.

Mr. Ertel. Thank you very much, Congressman Shamansky.

If I might just amplify on what Congressman Walgren said, I think I have taken out of here some things about the education programs. We talked extensively throughout this hearing of the need for venture capital. But, also, we talked about human resource development and having a literate group of people who can develop an industry or a technology. And what I have taken away from here, if I might, is that I see from our budgets in the United States Government, a complete opposite approach from what I have heard here.

My view of the educational process is that the greatest thing that ever happened to the United States was the GI Bill after World War II. We upgraded an entire segment of our population into an educational realm which they, probably, would never have gotten without the GI Bill. Replacing the GI Bill were guaranteed student loans and other types of programs which kept, or expanded, that base of education in the science fields which the National Science Foundation followed along with.

And we continue to expand that, not only just for men, for which the GI Bill was designed because they were the veterans, but we expanded to women and to minorities. We continued to expand that educational base so that we could, in fact, do the things you are talking about, increasing the scientific and educational base of the United States, and developing our human resource which then develops into actual capital and capital investment.

In the last year, I have seen us cut student loan programs almost in half. Our graduate fellowships are diminishing dramatically. Our science and education budget is basically zeroed, as you have indicated here. In short, we have zeroed out what is really the life blood of America, its people, its educational process. We are going backwards, very dramatically, to pre-World War II days. And that concerns me, and I think it should concern you as a member of the Academy of Sciences here in Ohio. You and Dr. Ungar are the ones who have to deal with the people that eventually will staff your institute, who have the ability to develop those technologies. These people are the ones coming out of this educational process.

I wonder if you might comment whether you agree with what I have said that we are going back into a time, which I don't think America can go to, if we are going to develop high technologies, an educated population, and our human resources in this country.

Mr. **Elfner**. Well, let me speak specifically on the NSF budgets. For the past 10 years or more, there has been very little in the NSF Science Education budget that benefited the State of Ohio. One program in particular, which I can trace, specifically, to the students, whose names I have given you, were summer student training programs in the colleges, where, maybe, a $15,000 grant would pay for part of a faculty salary, some housing, some equipment, and, as a result of that, about 25 students would come out of there who were 2 to 3, to 4 years ahead of any other students in the State of Ohio. That kind of a categorical program had an impact on Ohio, and I can trace it to individuals.

The curriculum studies—now, I have taught science. I have worked with science educators. I have worked with industry, business, foundations, what have you. Quite frankly, to be real honest with you, most of the money spent by National Science Foundation on curriculum studies has been a sheer waste. Now, I know there are going to be people that will criticize me for that, but I taught science. I saw what happened in our school. Not a single influence of NSF in curriculum studies affected the school where I taught, but I have kids that are out in business and industry now. One is a bank president, directly a result of the skills and things that I taught.

So, I don't think that you need large amounts of Federal dollars to turn around science education. I do think that, if you are going to spend science-ed money, it has got to be directed locally. It has got to be categorized for States and local entities, like COSI. Because that is where it has the effect.

Now, one more comment. There is no question in my mind that in the economic conditions we have now, that student loan programs are absolutely more essential than they have ever been. There is a lot of fraud in the student loans. We know about that, but that is a management problem. You have got to look at it in terms of what are the opportunities you are providing these students for? And you have got to insist on those kinds of opportunities and providing that. That is venture capital in the ultimate sense. You are venturing on the lives of these students and future technology leaders. Thank you.

Mr. **Shamansky**. Thank you very much.

Mr. **Walgren**. Dr. Ungar wanted to say something more.

Mr. **Shamansky**. Yes.

Mr. **Ungar**. I was going to say that I have, really, no expertise in the financing of students, other than that derived from financing two privately. I will say, and I will add to the statements that were made by Dr. Adams and Dr. Glower this morning that there is a very serious problem in the science and engineering schools in the country. The manner in which these are resolved, I can't really recommend. On the other hand, I am concerned about the problems of financing facilities and insuring that the faculties are sufficiently compensated, that they stay on the university staffs, and, finally, that graduate students stay around in the science and engineering areas, so that they go on and get their Ph. D.'s and become the cadre to be the teaching staff of the future.

Mr. **SHAMANSKY**. I would just like to note that we have heard testimony over the past year that the graduate students, the doctoral candidates, in science and engineering, are almost half made up of foreigners—non-Americans—and, yet, the administration now proposes to do away with guaranteed student loans for graduate students. Now, that sets up a problem for some of us, and I do not suggest that this is a partisan matter on our committee. Both Republicans and Democrats are concerned about that particular decision and the long-range significance of it.

I would like to thank the witnesses, and I think everyone owes a debt of thanks to Sandy Hallock and the staff of COSI for making available to us the auditorium. Their cooperation has been splendid. We are very grateful to you, Sandy, for your cooperation.

I want to thank Chairman Walgren and Congressman Ertel for joining us. They had a heck of a time getting here, as you know, and, of course, Congresswoman Schneider, who, luckily, came in a little earlier.

I'd like to say that at 12:30 a luncheon is being sponsored by the Columbus Area Chamber of Commerce, and I declare this meeting adjourned.

Thank you very much for attending.

[Whereupon, at 12:16 p.m. the hearing was adjourned.]

APPENDIX

THE ROLE OF ENTREPRENEURSHIP IN ECONOMIC DEVELOPMENT AT THE LESS-THAN-NATIONAL LEVEL

by

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ENTREPRENEURSHIP AND ECONOMIC DEVELOPMENT AT THE LESS-THAN-NATIONAL LEVEL

The translation of policy and theory into workable action programs is an art form that is little understood and seldom practiced successfully. Nowhere is the gap between theory and useful action more apparent than in the field of economic development at the less-than-national level; that is the level of region, community, local and rural area. This paper is one effort to help close the gap betweeen generalized goal statements and useful operational programs for economic development at the less-than-national level. More specifically, this paper is concerned with discussing and suggesting research efforts focused on eliciting and developing one aspect of entrepreneurship--company foundations--at the local level. The suggested research efforts are for consideration by the Economic Development Administration (EDA), and are directed to the interests of agencies, organizations and individuals engaged in the implementation of economic development in geographically delimited areas. No effort is made to engage in the interesting and ongoing controversies that mark the field of economic development theory.

The material that follows includes:

- A discussion of some aspects of economic development at the less-than-national level
- A delineation of various views of entrepreneurship and its relationship to economic development
- A review of available literature on one aspect of entrepreneurship--the company formation process, the factors that enter the process and affect the number of formations in a given community

-- A discussion of ways to elicit and develop company formations, and to develop the knowledge needed (research programs) to make the process more effective.

Some aspects of economic development at the less-than-national level

Contrasting Manchester and Birmingham, England in the mid-Nineteenth century, Jane Jacobs, the architectural writer and critic, seeks for clues to long-term dynamism at the community level. She points out that Manchester was held up by the knowledgeable writers of the period as a paragon of efficiency, the model of the future (Jacobs, 1969). At that time in history, Britain dominated the world in textiles, and Manchester was the heart of Britain's textile industry. Cotton-texile manufacturing was concentrated in a small area around Manchester. The city was near the great port of Liverpool. The coal, the necessary pure water, the humid climate were available to make Manchester a natural hub of textile manufacturing. Supplementary and supporting industries, such as cotton-textile machinery and dye manufacturing, clustered nearby (Dillard, 1967). At the same time, Birmingham was

> . . . precisely the kind of city that seemed to have been outmoded by Manchester . . . Birmingham . . . had no specialty of the kind that made Manchester's economy so comprehensible. . . . But as it turned out Manchester was not the city of the future and Birmingham was . . . Manchester had acquired the efficiency of a company town. Birmingham had retained something different: a high rate of innovation. Indeed, Birmingham and London are the only two cities in Britain today that retain a significant capacity to create new work from their existing work. . . . (Jacobs, 1969)

Reading Jacobs' description of Manchester and Birmingham suggests two aspects of development worth noting: (1) Economic development does not happen "in general," but to specific people in specific places, and (2) the goals of economic development at the less-than-national level must go beyond "increased jobs and income."

The historical experience of Manchester and Birmingham reminds us that economic development is an expression of the actions and experiences of people with names who are found in named places. Stating it more formally, Cumberland writes,

> Regional and urban development represent the spatial disaggregration of national economic development policies as those policies directly affect people and their lives. . . . (Cumberland, 1973)

People identify themselves with domicile, community and region. They act as if attachment to place is important in their decisions and actions. Increasingly, scholars are coming to accept this idea that few individuals act as economic maximizers responding rationally and instantaneously to perfect information about the economy. Rather, the population is seen to be made up of satisficers and suboptimizers who are willing to forego many obvious kinds of economic benefits for the sake of enjoying other less "rational" benefits. Consequently, it is reasonable that we seek out economic development approaches and programs that are geared for application at the community level, and that are capable of drawing upon and reflecting local peculiarities and predilections.

Despite the widespread preoccupation with economic development we do not have a commonly accepted definition of economic development or its goals. Regional economic development policy is expressed in terms of "more jobs and more income." In addition, some regional development programs include goals in terms of "balanced growth," "fiscal stability," "equity," or some increment to GNP or regional exports.[1] Unfortunately, as must be inferred from Jane Jacobs' description, more jobs, income, GNP and regional exports were not enough to sustain Manchester. Set in somewhat broader and more formal terms, the goal of economic development for the lesser developed countries includes the notion of a continuing process, but leaves the process unspecified, " . . . a state in which the people have the material opportunities for using their talents, of living a full and happy life and steadily improving their lot" (quoted in Schumacher, 1973).

One might argue for a clearer picture of the characteristics that denote an area that has reached the desired state, and argue that the goals of development are more usefully stated in terms of processes than in terms of output. The essential differences between Manchester and Birmingham over a century ago were not differences in jobs, GNP or income, but differences in certain dynamic qualities, such as the capability for innovation and self-initiated responses to events.

What we really want for an area (or more precisely, for the people within the area) is to achieve a state denoted by resilience--the ability to respond to changes in the environment effectively, creativity and innovativeness--the ability and willingness to experiment and innovate, initiative taking--the ability, desire and power to begin and carry through useful projects. Preceding and accompanying the dynamic characteristics of resilience, creativity and innovativeness, and initiative-taking is diversity. Obviously, diversity offers an area some measure of invulnerability to the effects of many unforeseen events and decisions; with diversity there is always part of the local economy relatively unaffected by changes in a single industry or marketplace or legal constraints on a given product.[2] Less obvious, but perhaps as important, diversity provides a favorable environment for creativity and innovativeness. Where variety and diversity abound there is a higher likelihood for achieving meaningful associations of items not previously associated, one definition of creativity.

Economic development programs at the less-than-national level concentrate on the more easily measured goals of more jobs and more income. Typically, a city or regional development authority launches an intensive campaign to attract large industrial plants in order to generate the targeted jobs and income. In the effort to attract large plants, many kinds of concessions are offered to the concerns being wooed; tax breaks, free or cheap land, long-term and low-interest loans, buildings, utility development, highway construction, railroad spurs. The probabilities of attracting a plant are overlooked, and the full consequences of attracting a major plant are not really understood. One study made in the late 1950's found that in the United States at that time there were approximately 16,000 development organizations competing for 200 available corporation moves; the efforts cost well over $250 million.

If the effort to obtain a plant succeeds, there is a high probability that the incoming company will bring its managers and highly skilled workers from other areas, while the local area provides the low-cost, unskilled workers. A flow is set up in which the skilled, professionally trained youth of the community leave for other cities while the unskilled youth of the community and the unskilled workers of other communities are attracted and retained. The result of an in-migrating company, attracted by cheap labor and low costs can be to lower the net quality of the human resources of a community.

With a large in-migrant company comes an enlarged workforce. The new workforce sets up a demand for all of the services that the cities provide their citizens; for police, fire protection, education, waste disposal. The tax demand goes up, but the incoming company frequently has been given a tax concession and is freed from paying the taxes generated by its presence.

Finally, the incoming company makes the community vulnerable. The community adjusts to the dominant source of jobs and income in the community, becomes dependent on it. The vulnerability is made apparent when it is suddenly realized that decisions about the local plant are made by a distant, uninvolved management that can easily shift its plant to a lower cost region. Of course, managements are not eager to disrupt communities, and many corporations deliberately refuse to locate in a community where their decisions will have large social or economic effects.

Considering the negative economic and social consequences of dependence on a single crop, a single industry or a single resource (be it a mineral deposit or cheap manpower) it is surprising to find the extent to which local development officials still expend so much effort on attracting a single major corporate division to employ their "cheap" labor. A recent example of how the apparent short-term advantages gained through importing many industrial plants to provide jobs and income for local workers had long-term negative effects for a region can be found in the Mexican-American border program. In ten years the program attracted some 450 American manufacturers through the bait of low-cost labor. Now that wages are improving (though still low by any standard) the companies are leaving for Central America, the Far East and Ireland where wages are lower yet. 1974-1975 witnessed a 30 percent decrease in employment in the area, and 25 to 40 percent of the in-migrant American plants have closed down, moved to other regions or severely reduced their operations, leaving a very serious social and political problem in their wake (NY Times, 26 May, 1975).

If not through jobs and income, how then might we frame our economic development goals so that we could achieve the requisite diversity and develop the desired resilience, creativity and innovativeness, and initiative taking in an area? A fairly reasonable case can be made for a program to elicit and develop entrepreneurship in the form of company formations in an area. A program with targets set in terms of company formation rates has the potential for generating and embedding the desired characteristics in an area. By its very nature entrepreneurship is concerned with the introduction of variety, innovations, and new ventures in a locale. Company formation is initiative-taking behavior, and entrepreneurial responses are the operational expression of resilience or response to the environment in change. Describing Birmingham in the 1850's Jacobs writes, "It was always a peculiarity of Birmingham that small household trades existed which gave the inmates independence and often led--if the trade continued good--to competence or fortune" (Jacobs, 1969). Jacobs goes on to state that many of these endeavors failed and that they did not constitute a majority of the city's industry. Nevertheless, Birmingham's peculiarity led to the development of a diverse, responsive, resilient capacity that serves the city 125 years later.

Entrepreneurship

Entrepreneurs and entrepreneurship have occupied the interest of scholars of economic development since the early 19th century when,

> J. B. Say . . . in the the French (Cantillon) tradition, was the first to assign to the entrepreneur--per se and as distinct from the capitalist--a definite position in the schema of the economic process . . . the entrepreneur's function . . . to combine the factors of production into a producing organism . . . he is the pivot on which everything turns. . . . (Schumpeter, 1954)

The entrepreneur and entrepreneurship have appeared and reappeared in the literature of economic development in a variety of forms depending on the time frame and the particular scholar's field (Kilby, 1971). To some, the entrepreneur is the sine qua non of economic development whether conceived of as an innovator serving as prime mover in the economic process or as a generalized function in a more formalized model of the economic process. As economics has become more formalized, others have either ignored the subject or treated it as part of a

> . . . catch-all residual factor. The latter residual, variously termed "technical change" or "coefficient of ignorance," includes, among other things, technology, education, institutional organization, and entrepreneurship (Kilby, 1971).

The "entrepreneur" has been defined and discussed in a variety of senses. Schumpeter treated the entrepreneur as the individual whose function is to carry out new combinations called enterprise (1935) and later as the innovator, concerned with doing new things or doing old things in a new way--an innovator (1947). To Cole (1959), the entrepreneur is the individual or group of individuals who undertakes ". . . to initiate, maintain, or aggrandize a profit-oriented business unit for the production, or distribution of economic goods and services;" to others, the entrepreneur is variously a risk-taker (Drucker, 1965), and organization builder (Harbison & Myers, 1959), a decision maker (Harris, 1973). McClelland (1971),

> . . . would like to divorce 'entrepreneur' entirely from any connotation of ownership. An 'entrepreneur' is someone who exercises control over production that is not just for his personal consumption . . . for example, an executive in a steel-production unit in the U.S.S.R. is an entrepreneur.

In one writer's eyes the firm itself is the entrepreneur (Strauss, 1944). Each of the writers in the field attempted to encompass something of the innovativeness, energy, action orientation that was evidently of importance in accounting for economic development and innovation, to account for,

> . . . a quality in economic life whose influence is easy to recognize but hard to define, and harder still to place systematically in economic theory. Wherever development has most vitality, there seems to be an element of original adaptation, a restless adventurousness in the search for opportunity which cannot be simply explained by the presence of exploitable resources. Let us call this quality entrepreneurship: a practical creativeness which combines resources and opportunities in new ways. . . . (Marris and Somerset, 1971)

It is tempting to explore the many writings on entrepreneurship in depth and to evaluate the overall effect of enterprising behavior in every sector of our society. There is a growing literature on entrepreneurship within the government sector and within civic life, but for the purposes of this discussion, the entrepreneur is defined as the person who starts ". . . business enterprises . . . the innovating entrepreneur who develops an ongoing business activity where none existed before" (Collins and Moore, 1964), or, in even greater contrast from those who essentially see the entrepreneur as a modern manager,

> . . . the active initiator of a new enterprise in the form of a new company . . . with a major role in starting the company and managing it, and usually with an equity position in it. . . . (Draheim, Howell and Shapero, 1966)

The company former(s), or venturer(s), or enterpriser(s) bring together resources to organize and manage a new company; and are not necessarily the individual(s) who conceived the idea for the company, invented the product or service manufactured and sold, or provided the capital. We should not conclude, as have some writers, that all managers are by definition entrepreneurs. Furthermore, we should not conclude that all inventors are entrepreneurs. There are some very well publicized examples of great inventors who have also been successful company formers, such as Land of Polaroid and Beckman of Beckman Instruments; these are very exceptional cases. More often than not, an invention finds it way into public use through the actions of an entrepreneur who must pry it loose from the grasp of its creator before it realizes its potential in the market place. The entrepreneur is an inventor or innovator in one sense, for every new company formed is an innovation; whether in terms of product, form of organization, location or method of selling.

To repeat, throughout this report the term 'entrepreneur' is used in the restricted sense of the 'company former' or 'company founder,' 'entrepreneurship' will be used interchangeably with 'company formation' or 'company formation process.' The restricted use of the terms 'entrepreneur' and 'entrepreneurship' is not intended as a fundamental argument for redefinition of these widely used terms, but only as a clear delineation of the aspect of entrepreneurship that is being discussed here with regard to economic development at the less-than-national level.[3] It is necessary to consider the sense in which the terms are used, since each of the many interpretations of entrepreneurship imply very different development efforts. The view of entrepreneur as industrial manager (McClelland, 1971) implies research into the makeup and motivations of industrial managers and leads to programs to modify the motivational structure of nascent managers and to provide managerial training. The view of entrepreneur as company founder implies research into the company formation process and leads to programs to elicit company formations in a target region or population.

The company formation process and local economic development

Programs to elicit and support the company formation process in a locale offer potentials not readily available through other approaches. By adding a program to encourage company formations to the economic development repertoire of an area, the following possibilities are generated:

(1) An area capability for fielding appropriate responses to events in the marketplace as they occur: A well diffused tendency to respond to opportunities by starting new companies combined with a capability for succeeding in the efforts gives an area the means for dealing positively with whatever happens in the unknown future as differentiated from efforts to project or predict what will actually happen. It is essentially a case of focusing on developing a response capability rather than on developing specific responses to projected futures. Of course, the company formation process tends to occur in sectors where heavy capital investment and long lead times are not required; almost by definition new companies are small companies.

(2) An actuarial approach to events: A multiplicity of companies, as differentiated from one or two major corporate divisions, provides an area with a multiplicity of independent decision-making units with each assessing the environment from a somewhat different vantage point. A variety of assessments provides a higher likelihood of coming up with appropriate responses than can be obtained through one or two assessments. Though large corporate organizations can draw upon large staffs, the staffs must reach a unified outlook for each decision appropriate to the whole corporation. Consequently, a large corporate division represents one decision point in a community with a high likelihood that the decision is made from a viewpoint that is not locally oriented.

(3) A greater tendency to innovate: Each new company is an invention or innovation in itself. An increase in the number of companies formed in an area is an increase in innovative behavior by itself, and, as will be shown later in this report, each new formation (and innovation) raises the probability of the next one occurring. Furthermore, there is an extensive history of innovations, particularly high technology innovations, that were generated and/or brought to the marketplace through new companies. From the viewpoint of society, entrepreneurship provides operational expression to new ideas, new structures, new products, new devices. Each company formation is an action experiment, testing some new combination of resources and processes, some new approach to the environment. In the aggregate, entrepreneurial events provide society with a relatively low-risk, low-cost (actuarial) approach to the problem of testing creative approaches to an unknown, onrushing future.

(4) Valuable social learning at very little political and economic risk: The positive effects of successful and growing enterprise are obvious; however, the benefits that accrue to an area from a failed, new and small enterprise are

completely overlooked. A failed enterprise may be a highly traumatic experience for the founders and those who have financial stakes in the enterprise, but it is seldom a net loss for the community in which it occurs. Each failed enterprise is a generator of social learning for all those who have been associated with the enterprise: founders, employees, suppliers, bankers, lawyers, accountants and customers. Empirical studies of company formations have shown that many successful entrepreneurs have failed at least once before their current success. Henry Ford failed in business twice before he finally succeeded (Hughes, 1965). ". . . Individuals who previously owned a business have a much lower failure rate than those who have never been in business. . . ." (Dickerson and Kawaja in Pfeffer, 1967). If a community retains those who were a part of a failed enterprise, there may be little loss from the viewpoint of the community for the experience, skills, capital remain available for other efforts.

From the viewpoint of the concerned public official a program to encourage many company formations is a relatively low-risk and potentially high-gain effort. It shifts attention and responsibility to the successes and failures, in aggregate, of the many company formation efforts (another actuarial aspect). A program that generates several entrepreneurial formations distributes the political and economic risks over a large number of smaller and less visible points than does the program that is focused on one or two large, expensive, highly-visible, long-term projects. Furthermore, a program to encourage many new companies to be formed has a fair likelihood of producing some successes early and during any single year of the program while a very large project takes several years before success or failure can be determined.

(5) Cultural fit: The entrepreneur, even when drawn from a minority or immigrant group, is part of the fabric of the culture in which he is found. The

entrepreneur lives close to and is part of the culture of the country and region and locale. He is attuned to place and custom, and has an intimate awareness of what can and cannot be done with local resources. Unlike the manager of an inmigrant industrial plant, the local entrepreneur does not have to be "oriented," taught how to understand the local natives, given language lessons, taught about the local customs.[4]

An entrepreneur is a product of his culture. A French entrepreneur is a French product. Even more, a regional entrepreneur is a concentrated expression of local outlooks, values, prejudices, conditions, traditions, needs and capabilities. The local entrepreneur is more likely to bring a special passion and devotion to his efforts in a locale that affects his willingness to 'hang on,' his desire to do something for the locale, and his willingness to forego the maximization of some particular economic variable that would require relocation in some other area.

The company formation process

The key questions of this paper concern the company-formation process and how it may be elicited and supported for the economic development of an area or community. What do we now know about the process in a systematic and utilizable way? What research might be usefully undertaken to supplement what is now known? How do new companies get started? Who starts them? Are there systematic patterns of antecedents to company formations, and are they amenable to manipulation? What are the critical barriers to company formation, and what may be done to eliminate or minimize them? How does the company-formation process vary by culture, industry, region, locale? Are there any manipulable variables in terms of financing, education, taxes and law that are particularly influential in the subsequent survival or failure of new companies?

What kinds of industries are easy to enter and which of them should a community attempt to foster?

For the past few years, there has been a continuing, though not always persistent, interest in studying new company formations. Scholars from a variety of disciplines have examined and delineated the contextual, situational, social, economic and psychological factors that appear to affect entrepreneurship in general and company formation in particular. Some of the findings are examined in the following pages, and a particular conceptualization of the company-formation process is presented here as a vehicle for presenting much of the available empirical evidence. The same conceptualization is used as a means for suggesting relevant areas for research and experimentation. The approach taken is empirical and action oriented and is not intended as a contribution to theory in any specific discipline. The data used are drawn from studies made in various parts of the United States, in other countries, and a variety of industrial sectors. The conceptual frame of reference is cast at the level of social and institutional interaction rather than at the national, aggregative level; at the level occupied and operated upon by regional and local development organizations.

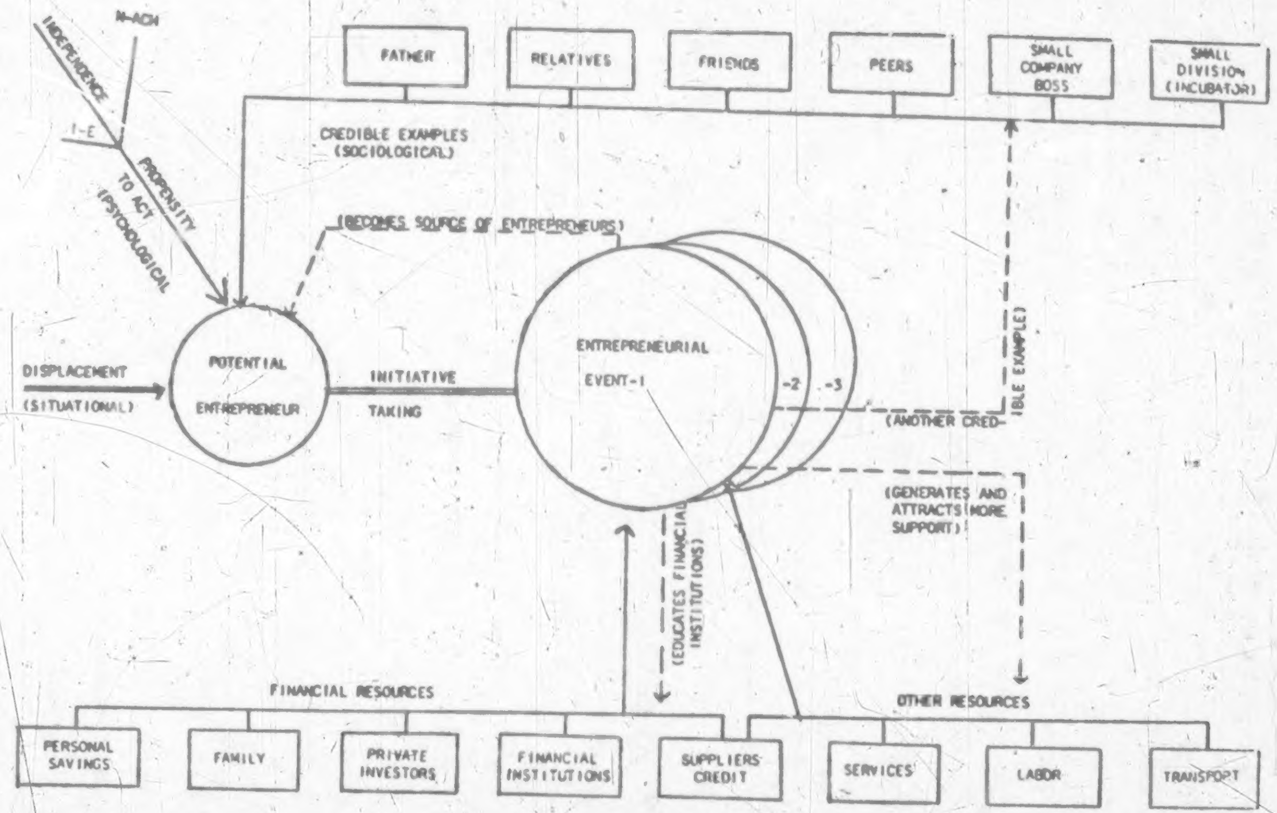
Each year some hundreds of thousands of new businesses are formed in the United States.[5] Each of these company formations is the culmination of a process that is affected by place and time, by the social and economic climate, by the nature of the sector of the economy and by the nature of the individuals forming the company. Though each formation is a unique event, examination of the data for a large number of company formations in different countries, regions, and economic sectors suggests that there is a fairly consistent general pattern for the company-formation process. To be sure, the general pattern is highly complex and multivariate; nevetheless a pattern can be discerned which goes a long way toward explaining the majority of formations. The general pattern includes four major elements that combine in an overdetermined manner, in that no single factor by itself accounts for the formations studied and no fixed distribution of the four elements applies to all formations. All four elements must be present though they are partially substitutable for each other.

The four major elements that go into the company-formation process are the following: (1) Displacement of the nascent entrepreneur(s)--a situational variable, (2) an apparent disposition to act on the part of the nascent entrepreneur(s)--an individual psychological propensity, (3) examples or models of behavior that impart credibility to the act of forming a company for the nascent entrepreneurs(s)--a social psychological or culturally contributed variable, and (4) availability of resources to the nascent entrepreneur for starting a new company--an economic variable (See Figure 1).

Displacement. The formation of a company is a distinct, discrete event that requires explicit legal, financial and organizational actions on the part of its founders. Yet of the many company formations studied, seldom are any found that resulted from a rational, calculated, carefully planned succession of decisions and actions. How, then, is the company-formation process initiated? We find that most company formations are associated with some kind of personal displacement, some dislodgement from a comfortable or otherwise acceptable state of being. Some other company formations are initiated during a period when the founder is out-of-place; that is, not-in-place, between things, not yet lodged in an acceptable state. The displacements that initiate the company-formation process can be both negative and positive, externally imposed or internally perceived, and it is often a combination of negative pushes and

Figure 1

The Company-Formation Process


N-ACH
INDEPENDENCE
I-E
PROPENSITY
TO ACT
(PSYCHOLOGICAL
FATHER
RELATIVES
FRIENDS
PEERS
SMALL COMPANY BOSS
SMALL DIVISION (INCUBATOR)
CREDIBLE EXAMPLES (SOCIOLOGICAL)
(BECOMES SOURCE OF ENTREPRENEURS)
DISPLACEMENT
(SITUATIONAL)
POTENTIAL ENTREPRENEUR
INITIATIVE
TAKING
ENTREPRENEURIAL
EVENT-1
-2
-3
(ANOTHER CRED-IBLE EXAMPLE)
(GENERATES AND ATTRACTS MORE SUPPORT)
(EDUCATES FINANCIAL INSTITUTIONS)
FINANCIAL RESOURCES
OTHER RESOURCES
PERSONAL SAVINGS
FAMILY
PRIVATE INVESTORS
FINANCIAL INSTITUTIONS
SUPPLIERS CREDIT
SERVICES
LABOR
TRANSPORT

positive pulls that combine to precipitate the actions leading to the formation of a company.

Negative factors appear to be far more instrumental in precipitating entrepreneurial actions than are the positive factors that loom so large in the literature on rational approaches to starting a new company, such as perceived market opportunities. There is a spectrum of negative antecendents to the company-formation process. The most definitive displacement in the spectrum of negative antecedents is that experienced by the political or religious refugee who is in exile from work, home, culture, and language, and who does not have the option to remain in place. Moving along the spectrum we find the terminated employee, displaced from work and potentially displaced from home; also without the option to remain in place. There are other kinds of work related incidents and situations that have been identified by company founders as triggering the founding of their companies: the company they worked for had decided to move the plant or to transfer them to another city to which they did not want to move; colleagues had been laid off and they felt that it would eventually happen to them; cancellation of a project or rejection of a proposed project with which the potential entrepreneurs identified; promotion of colleagues over them, which they perceived as relative displacement.

Some displacements are internal to the entrepreneur in that they are internally generated without reference to outside occurrences. One recurring precipitator of company formations can best be referred to as 'traumatic birthdays' or 'magic numbers.' The entrepreneur replies to the interviewer, "I realized I was going to be 40 years old within three months. It was now or never." Other such numbers given are 30 years old or 50 years old. (Interestingly, in the studies conducted by the author of this report, the ages of entrepreneurs at the time of company formation range from teen-agers to a French engineer who was 73 years old at the time he started his company.)

Each wave of political refugees has produced its own special history of company formations in the country to which they fled. The French refugees from the former French colonies of Tunisia, Algeria and Morocco who resettled in France, the East German refugees in West Germany, the East Indians forced out of East Africa have been responsible for the formation of a large number of new companies in their new home areas. In recent years the wave of Hungarian and Cuban refugees into the United States and now the new wave of refugees from Viet Nam have made their mark in terms of new companies. In a special report by the Bureau of the Census on minority owned businesses in the United States (Bureau of Census, 1972), which did not include all sectors of the economy, it is reported that by 1972, 13 years after they started coming out of Cuba, the Cubans in the United States were responsible for 4,664 existing companies, 1,266 of which had paid employees and 848 of which were in construction and manufacturing. A study of entrepreneurs in Lebanon (Sayigh, 1962) found that several were Palestinians and presumably refugees. Analysis of biographies of the Mexican enterpreneurs in Derossi's (1971) study shows that a noticeable percentage were refugees from Germany and Lebanon. Papanek (1962) reported whole groups of Memon muslims who were refugees from India and who were very entrepreneurial in Pakistan.

In studies of 109 company formations in Austin, Texas (technical companies, accounting firms, publishing firms) it was found that 65% of the influences leading to the startup of a new company were classified as negative (Shapero, 1975).

The identified influences included the following: "getting fired," "boss sold the company," "organizational changes," "being transferred but did not want to leave the city," "no future," "didn't like the job." Twenty eight percent of the influences that were classified as positive included: "encouragement by peers," and more importantly, "encouragement by customers and bankers." Just under 10% of the remaining responses were identified in terms of "being between things" or being out of place at the time.

Other studies of entrepreneurship in a great diversity of environments provide strong support for the inference that negative displacement is important to the initiation of the entrepreneurial efforts. Studies of Filipino manufacturing entrepreneurs (Carroll, 1965), Pakistani industrial entrepreneurs (Papanek, 1962), industrial entrepreneurship in the state of Madras in India (Berna, 1962), industrial and technical entrepreneurs in Northern Italy (Shapero et al., 1973), small businessmen in the United Kingdom (Boswell, 1972) and industrial entrepreneurship in Turkey (Alexander, 1960) all report anecdotal and statistical information that can be considered evidence of displacement. Carroll (1965) writes of the effect of the pressure of severe import controls which triggered merchants into entering the manufacturing field. Similar findings concerning the effects of import controls on industrial formations were made by Papanek, Berna and Alexander. Further, Carroll quotes several instances of Filipino entrepreneurs being launched on their careers by negative displacements: having one's taxi horse taken away by the Japanese, losing one's job with the government because of the war, a family business argument, the close-down of a plant. Boswell writes of "... the emigration of frustrated men from corporations" as being a prime generator of new engineering and hosiery/knitwear firms in the United Kingdom.

As with explicit displacement, the state of being out-of-place or between-things often precedes the formation of a company by a nascent entrepreneur. Typical lifetime situations when one is out-of-place and therefore more likely to start a new venture include discharge from military service and completion of studies. Such situations are particularly effective with experienced individuals who have been working and then been called back into service or those who have returned for further education. There is one study of 22 ex-offenders who started their own companies when the were paroled from prison (Jansyn et al., 1969), another between-things condition.

Voluntary migrants also rank high as company founders. Derossi's Mexican entrepreneurs included a high percentage of first generation immigrants and their heirs. Derossi also mentions similar findings reported from other Latin American countries (Lipman, 1965; Zalduendo, 1963). The voluntary migrant, whether migrating to escape some negative situation (negative displacement) or to exploit perceived opportunities, is a voluntarily displaced person; a person who is out-of-place for some time period. The data mildly support a speculation that the more the migrant is out-of-place in his new environment, the more likely it is that he might start an independent venture. Derossi's study shows little or no entrepreneurship displayed by refugees from the Spanish Civil War who fled to Mexico, which might be attributable to their education in the liberal professions and their language. It appears that the Spanish professionals found themselves easily in place in Mexican society in terms of professional opportunity and common language.

In explaining the development of entrepreneurial behavior in individuals, Hagen (1962) identifies two exogenous variables as being instrumental, withdrawal of status respect and relative social blockage. Both of the variables identified by Hagen are negative; the first can be classified as a definite negative displacement while the second might be classified as being out-of-place. Discussing Hagen's theory, Kilby (1971) writes,

> Hagen postulates that four types of events can produce withdrawal: (1) displacement by force, e.g., the Norman invasion of England or the derogation of merchants, samurai and wealthy peasants in seventeenth century Tokugawa Japan; (2) denigration of valued symbols, e.g., suppression of religious sects in seventeenth century Russia and England; (3) inconsistency of status symbols with a changing distribution of economic power; and (4) nonacceptance of expected status on migration to a new society, e.g., the Antioquenos in seventeenth century Columbia. . . .

Why does displacement figure so prominently in company formations? Starting a company is an act that requires a great deal of effort, personal commitment and energy. Though many people entertain the idea of forming their own companies, it is difficult for them to enter into the process due to many reasons, not the least of which is the inertia of their ongoing lives. Each individual tends to be held in place by a great number of balancing forces; a job, family needs, debts and obligations, the routines of every day life. It takes a significant shift in forces to enable the individual to make a major shift in his position in social and economic space. Thus, displacements play a large part in the initiation of most companies. In the same way, the condition of being not yet in place is prominent in the histories of company formations. As is often heard in interviews with individuals who started companies: "I knew it was now or never. I was just out of the army and knew that if I didn't take action now I would fall back into my typical patterns," or "I was going to be 40 years old on my next birthday. It was now or never."

Disposition to act. Many people are displaced, but a relatively small percentage of them react to displacement by undertaking to form a company, or, for that matter, to take any major initiative with regard to their own futures.

How then do the individuals who start companies differ, if at all, from those who take no initiatives? Several approaches have been taken to explain the psychological differences between entrepreneurs and non-entrepreneurs, to explain what is, in effect, the entrepreneur's disposition to initiate action. Collins and Moore (1964 & 1970) give what is essentially a Freudian interpretation of the entrepreneur, seeing the entrepreneur's actions as a result of unresolved fears of their father during childhood years. Consequently, Collins and Moore see the independent entrepreneur as one who cannot "... accept without reservation authority imposed on him by other people or by the impersonal organization. . . ." The establishment of a new business is the entrepreneur's means of "working through his oedipal impasse." McClelland (1961) attributes entrepreneurial behavior to those with a high need for achievement (nAch), and who manifest their high nAch in "... (1) their desire to take personal responsibility for decision, (2) their preference for decisions involving a moderate degree of risk, and (3) their interest in concrete knowledge of the results of decisions." McClelland, like Hagen, attributes much of the formation of the high nAch to childhood rearing practices. It must be remembered, however, that McClelland considers the entrepreneur to be a manager, and therefore he does not strictly differentiate the company former from the manager.

Another approach taken by the author of this report and his colleagues and by a widening group of other researchers has looked to the locus-of-control measure as differentiating between company formers and others. The reasoning which led to the use of locus-of-control instruments has been that company formation is an extraordinary form of initiative taking, and that initiative taking and the propensity to act should be related directly to whether or not the individual feels that it is possible for him to affect events, to affect the world around him. Locus-of-control instruments purport to measure the extent to which the individual perceives the control of his life to be external, by forces outside himself, such as luck, fate, or other powerful people, or internal, in his own hands. Internal people are apt to be relatively self-reliant and to want autonomy and independence, hallmarks of the entrepreneur.

In the recent studies of company formations in the United States and Italy (Shapero *et al.*, 1975), Rotter's locus-of-control questionnaire (Rotter, 1966) was used and, as might be expected, it was found that the company formers were far more internal than other populations that have been studied. On Rotter's Internal-External (I-E) Scale, on which scores can range from 0 (very internal) to 23 (very external) the Italian entrepreneurs studied had an average score of 6.06, while the average for the Americans studied was 6.74; both scores being far lower (far more internal) than scores recorded for any other group with the exception of Peace Corps volunteers. Considering the generally negative bias towards the small company and its ownership in Italy as compared to the United States where small businessmen are folk heroes, the differences between Italy and the U.S. are not surprising. An individual would have to be much more internal in Italy than in the U.S. to even imagine forming a company.

Comparison of a sample of French graduate students with a similar sample of graduate students of business at the University of Texas on the Rotter I-E Scale showed both groups to be far more external than the company formers studied in Italy and the United States. Also, the French students (I-E mean of 12.2) were found to be more external than the American students (I-E mean or 10.2). The relative externality of business students is not surprising to anyone familiar with the ambience that typifies most business schools. In effect, business schools are academies for corporate management rather than for entrepreneurship. The difference between the French and American students is also reflected in the sparseness of company formations in France as compared with the U.S.

In a study of the expectations of a cross-section of 375 business school students at the University of Texas, Borland (1974), using Levenson's locus-of-control instrument,[6] found that students with higher expectancies of starting a company at some time had significantly higher belief in internal control than those with moderate or low expectancy. Interestingly, the high and low expectancy groups did not differ significantly in nAch. Further, it was found that locus of control moderated the influence of nAch on expectancy of starting a company. Only among those with low belief in control by Chance (C) did students with a high nAch score have significantly higher expectancy of starting a company than those with lower nAch.

Throughout the psychological commentary in the literature on entrepreneurship there is the common thread of "autonomy" or "desire for independence." Though each of the writers quoted above used a different set of assumptions and different measuring instruments, all agree on the presence and strength of the desire for personal control of the environment by entrepreneurs: Hagen's "cannot accept authority," McClelland's "desire to take personal responsibility for decisions," Shapero's internality and associated independence and autonomy. In several studies conducted by the author of this report and his colleagues, entrepreneurs were asked what it would take (money or otherwise) to get them to accept a position as a manager or employee in someone else's company. Fifty-eight percent answered that there was no amount of money or title that would get them to accept such a change, while 28% set up extremely unrealistic conditions or demands which were equivalent to saying "No!"

When asked what they would do if they lost their current company, the entrepreneurs interviewed by Shapero and his colleagues replied in the following proportions: 72 percent said that they would start another company. In fact, many of the entrepreneurs who were interviewed previously had had at least one company failure. In a study of black entrepreneurs in South Africa (Hart, 1972), 68 entrepreneurs were asked, among other things, about their willingness to accept a job with higher remuneration than their net earnings from self employment. A majority--57 to 86 percent--would not accept any amount, 2 or 3 percent were uncertain, and the rest answered "yes" or a qualified "yes." The comments made by the respondents in the South African study give a better feeling for the intensity with which the idea of working as an employee for someone was rejected, ". . . I . . . I want to be committed to nobody. Independence is very important to me." ". . . I could never envisage myself going back to salaried employment after I have experienced the independence. . . ." ". . . I could not work for an employer now even though this business is not for rich people."

Imparting credibility to the act. Not everyone who is displaced and has a propensity to act turns his mind to starting a new company. In fact, starting a company may be considered an extraordinary act. It means trading the familiar for the unfamiliar, accepting a large measure of uncertainty, undertaking long-term financial obligations, commitment to long hours and a good possiblity of failure. What then influencs some individuals to start a company rather than to take any one of a large number of other actions? Career choices and changes are often matters of chance, but starting a company requires very deliberate action.

The most potent variable found associated with the company-formation act is the credibility of the act to the nascent entrepreneur. The individual must be able to see himself starting and operating a company, must be able to perceive himself in the role or else he cannot even begin to think about the act. From the data available it can be inferred that the way credibility is achieved is primarily by means of credible examples; company formations by someone "like one's self" or by someone with whom one can identify, someone drawn from the nascent entrepreneur's family or other of his reference groups.

The most prevalent and prominent credible example is provided by one's father or mother. In studies of company formations in a variety of industries and locations in the United States, the percentage of company formers found to have fathers/mothers who were independent (company owners, free professionals, independent artisans or farmers) ranges between 50-58%. This compares with a census count of less than 12% of the U.S. population listed as self-employed. In the Northern Italian study, the percentage of entrepreneurs with independent parents was 56%. In Carroll's study of the Filipino entrepreneurs, the percentage was 74%, in Marris and Somerset's study of Kenyan entrepreneurs, 80%, and in Harris's study of Nigerian entrepreneurs almost 89%. Borland found that the variable most positively associated with a business student's declared expectation or desire to start a company was whether the student's father had ever started a company. Not surprisingly, only one of 75 girls in Borland's sample expected to start a company.

The credible model or example is not necessarily one that is consciously followed. In a study of technical entrepreneurs by Susbauer (1969), those entrepreneurs whose fathers had been independent were asked if their fathers had been their models or had encouraged them to start a company. The usual answer was that their fathers told them never to start a company, and/or that their fathers had been unsuccessful. Nevertheless, the prevalence of independent fathers in the sample was remarkable.

Though the father or mother stands out as the major source of credible examples of entrepreneurship, there are many other sources of potential examples for the nascent entrepreneur. It might be inferred that the larger the number and variety of examples in a particular culture, country or locale, the greater the probability that the company-formation act will be credible to a larger number of individuals in that culture, country or locale. This may well explain the differences in proportionate role of parental example in different countries (U.S. 50-58% vs. Africa 80-89%).

Other credible examples include relatives, colleagues and classmates. Frequently, we find that there has been precedent entrepreneurial actions on the part of a brother, uncle, grandfather, classmate or colleague. Often the remark is made derogatorily of a colleague, "If he can do it, I certainly can!" When a corporate vice president breaks away to form a new company, this does not make the company-formation act credible to his many subordinates. However, when a group of engineers, far down in the organizational line break away to form a company, their colleagues are much more likely to follow their example (Draheim et al., 1966). In Cooper's study of technical company formations (Cooper, 1971) in the San Francisco area, he found that new company formations were more likely to have originated from small corporate divisions than from large ones. Cooper calls the small divisions "incubators." A small firm provides a close view of the man who formed or headed the firms; a man who in many cases is very much like themselves. In the small organization context it becomes possible for the potential entrepreneur to see the role of company head as credible for himself.

As was stated previously, many of the entrepreneurs studied were found to have formed more than one company, and many had experienced previous business failures. Failures apparently do not shake the credibility of the company-formation act, but may even reinforce the credibility of the act to the entrepreneur (as well as serving as a learning experience).

It is no accident that entrepreneurship is identified highly with certain ethnic groups: Jews, Lebanese, Ibos in Nigeria, Jains and Parsis in India, Gujeratis in East Africa. Each of these ethnic groups contains a large number of examples of company formation that established the credibility of the company-formation act for members of the group. In the case of the Jews, two thousand years of refugee status (displacement) and the presence of a large number of credible examples makes the company-formation act almost an expected role.

The availability of resources. Initiative taking, the disposition to act and credible examples are necessary but not sufficient for the formation of a company. The final required ingredient is resources. The company-forming entrepreneur must directly possess the labor, materials, equipment and facilities required for the potential venture or must obtain them by use of his or other people's capital. In times of readily available venture capital, the number of company formations goes up. In hard times, despite the displacement caused by job loss, the lack of available capital keeps the company-formation rate from rising.

If private or public venture capital sources are not available for certain kinds of industries, companies or entrepreneurs, fewer companies are formed or survive. Companies move from one city to another to take advantage of more responsive capital sources. The urban economist Thompson (1965) writes that the U.S. automobile industry moved from other areas of the country to Michigan in response to the urging of a single banker interested in automobiles and offering new automobile companies financial support.

The great majority of capital for new companies comes from the savings of the entrepreneur, those of his family and friends, from personal bank loans; personal and socially close sources account for over 90% of the initial financing for new ventures in the United States. Studies by Shapero and his colleagues found this to be true in their studies of 109 Austin entrepreneurs (Shapero, 1975), but this only confirmed what had been found in other studies of entrepreneurs in the United States (Delano et al., 1966) and of entrepreneurship in other countries. Similar results have been reported from Sweden (Dahmen, 1970), Italy (Shapero et al., 1973), South Africa (Hart, 1972), the Philippines (Carroll, 1965), Lebanon (Sayigh, 1962). Aside from personal sources, the primary source of startup funds come from private investors and trade credit. Despite the proliferation of various governmental development "banks" or "funds" of one kind or another, they play a small role in the startups studied to date.

New ventures almost never receive financial support from formal financial institutions. Banks are constrained to treat new company financing as 'not bankable,' though there are some exceptional examples of loan officers consciously making personal loans to individuals with little collateral for the purpose of starting companies. According to a recent National Science Foundation sponsored study, U.S. venture capital firms were found to make an average of just under three investments a year, less than 15% of them for new ventures. Since there is something less than 1000 of these highly publicized firms in the U.S., they can only account for about 450 startups. Even adding in the SBIC's, the special programs for minority entrepreneurship and various Federal programs, it is obvious that the role of the formal institutions is minuscule in the new company formation process in the U.S.

The process by which new or young companies actually get venture or almost-venture capital is not very well explained by the conventional literature on finance. Studies of the ways in which private venture capitalists and bank lending officials respond to the financial needs of new and young companies, particularly of those in new fields, suggest the existence of a process that is little understood in a systematic way. Furthermore, the available studies make clear that the presence of a financial community that responds positively to new companies is a key factor in whether or not a region will generate, develop, and keep new enterprises (Shapero, et al., 1969; Griggs, 1972; Hoffman, 1972; Benoit, 1974).

The development of an industrial complex in an area. To attain the desired characteristics of diversity, innovativeness and resilience that have been identified with a dynamic economy implies a multiplicity of companies and, by inference, the kind of industrial ecology or environment that facilitates the formation of the next company and the next company in answer to opportunities or problems. The factors going into the formation of a single company that have been discussed above provide the basic building blocks that go into the formation of an industrial complex or community, but there are other questions that need to be asked in terms of the "community of companies" as differentiated from the simple aggregation of individual company statistics. One question has to do with the kinds of companies sought. When one goes beyond the obvious kinds of companies that are linked perforce to the presence of local mineral resources or touristic countryside the choices are quite numerous. What kinds of companies should a community attempt to promote in its midst (or attract to its midst)? How do the individual company formations interact in the development of an economic community? What kinds of infrastructural needs are imposed by a program of entrepreneurship? What kinds of environments or industrial ecologies elicit, attract and enhance the kinds of companies that finally can become the core of a dynamic region?

What kinds of companies. The kinds of companies or economic efforts that are desirable for an area are those that not only bring jobs and income to the region, as has already been pointed out, but those that by their nature will enhance the quality of an area's human capital and its long-term capability to deal with the unknown future. Furthermore, in addition to desirability there is the question of feasibility; the kinds of new ventures that can succeed are those in economic sectors or niches that have ease of entry. The kinds of economic activity that exemplify what may be termed "high-value" companies for a community are companies that are engaged in high technology; the kinds of companies that are dependent on highly professional and skilled manpower. Many economic developers regard high-technology companies as especially attractive to an area's overall development program because the companies:

-- Utilize and develop products and technologies that may provide the basis for new, growth industries

-- Provide a community with an employment composition that has much higher than average income and educational levels

-- Attract a workforce that undertakes a large and active role in an area's educational, cultural and social activities

-- Create a community image that makes the area attractive to other kinds of economic enterprise

-- Provide employment opportunities that attract and retain an area's college-educated, technically and professionally trained citizens.

A number of studies of high technology industrial complexes in the United States provide us with some useful clues as to the way the process of development of an industrial complex occurs in the United States. The data even suggest that the process may be generalized to other than technical industrial complexes since they are primarily dependent on the individual company-formation process which has been found to be similar in many kinds of industry and different countries and cultures.

A description of the process appears in one study of the sequence of company formations that occurred in a number of different regions of the United States (Shapero, 1971). In that study, an analysis was made of non-metropolitan counties with at least one technical company[7] in the year 1968. Non-metropolitan counties were selected in order to be able to look at developments in areas most similar to the areas that were relatively more in need of development than the country's major centers.

As a result of the analysis of the data, the technical company-formation process in an area was categorized into three phases, differentiated by their technical company-formation rates. Though the three phases were not universal, they were identifiable in the majority of cases and they provide a convenient way of examining the overall success. The three phases were identified as follows (See Figure 2):

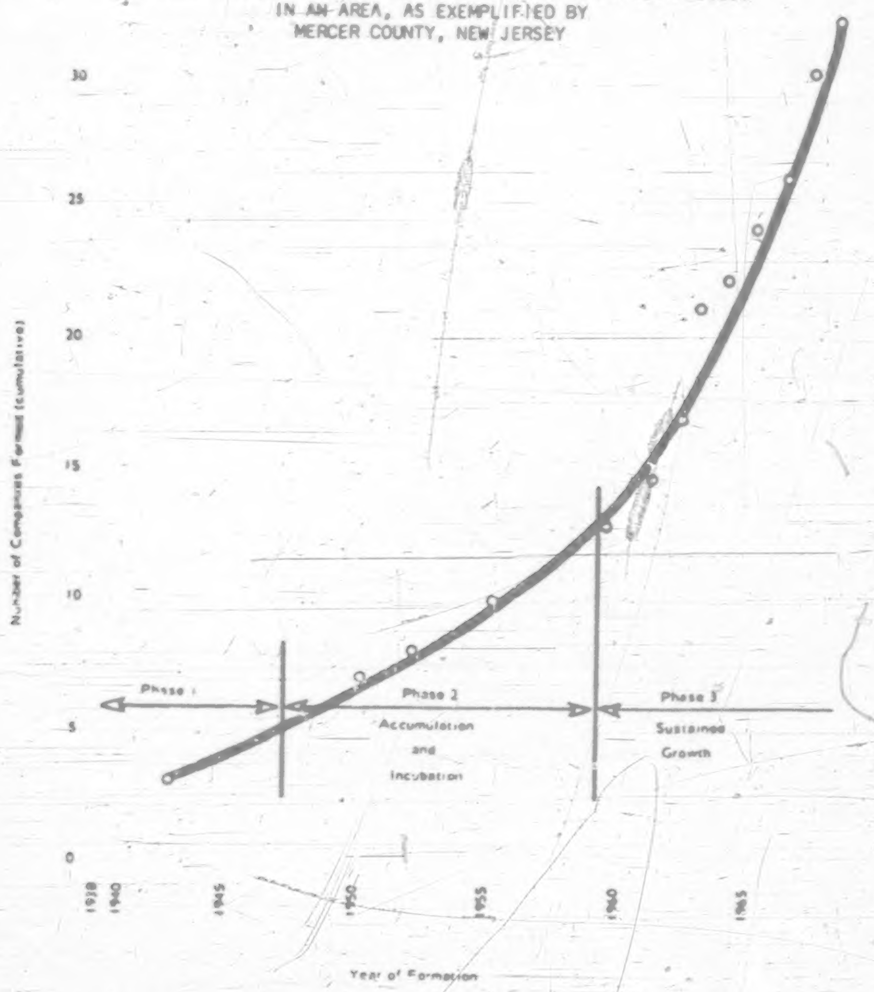
(1) A period in which the first one to four technical companies are formed, quasi-randomly

(2) A period of accumulation and incubation in which technical companies are formed at a rate of approximately one per year.

(3) A period of accelerated and sustained growth in which technical companies are formed at a rate of approximately two or more per year.

FIGURE 2

THE THREE PHASES IN THE TECHNICAL COMPANY FORMATION PROCESS
IN AN AREA, AS EXEMPLIFIED BY
MERCER COUNTY, NEW JERSEY



The initial sample consisted of 141 counties, from which a subsample was chosen consisting of 22 counties that could provide a better basis for an analysis of the complete technical company-formation process. The subsample consisted of counties that:

(1) Had reached the third phase of accelerated and sustained growth, thereby providing data on the kinds and mix of technical-company formations in each phase.

(2) Were not suburban. Counties that are suburbs of major metropolitan areas do not experience the same technical company formation process found in other areas, since the proximity of a large metropolitan area changes the number and kinds of companies formed.

The first phase -- the first company formed

The first technical company formed in a local area can be considered as an almost random event for seldom can the first formation be explained in terms of calculated decisions made by an "economic man" acting rationally. In almost every case the first technical company is distant from its markets, and there is little chance that its support services are available in a community that has not had previous experience with technical companies. In many of the instances studied, it was found that the first company founded survived in the area for decades despite the lack of important services and immediate markets. In sampling United States counties, it was found that at least half of the country's counties had at least one company that could be labelled 'technical.' Whether or not the first technical company in an area survives is a function of a number of factors such as whether or not the founder-manager is far better than average as a manager or technical professional, whether or not the company has a product or service sufficiently unique and salable to give the company a temporary monopoly in the marketplace, whether or not the company has access to financing and support services, and whether or not they are locally available. Often the first company survives through obtaining enought immediate sales and trade credit to make it independent of local financial support, and through supplying its own support services--even as marginal operations that take away form its profits.

The quasi-random, first company type of formation may be repeated with a second, third and fourth company, each completely independent or even oblivious of the existence of previous companies. After the first companies are formed and have survived, however, their very presence in the community becomes a definite positive factor in subsequent technical-company formations. In many cases, the first companies become sources of entrepreneurs for subsequent company formations through spinoff. Furthermore, each existing company enhances the credibility of company formation to others within the company and community. As personal displacements are experienced by employees or those dealing with the first companies, nascent entrepreneurs are triggered to take action. The presence of other technical companies makes founding a company a realistic and credible alternative.

The second phase -- accumulation and incubation

As the number of technical companies formed in the community increases, the technical company-formation process loses its random nature and enters a phase of accumulation and incubation. There is the beginning of a technical labor pool, the market for supporting services grows and begins to attract manufacturers' representatives, and the area gains warehousing of needed supplies. Supporting services are exchanged among the technical companies in the city, and local providers of professional services become "educated" to the special character and needs of technical industries.

During the second phase of development, because of its growing technical character, an area often attracts industry. A large corporate division, added to the accumulating number of locally generated companies, provides considerable impetus to the creation of a local technical labor pool, the attraction of suppliers and services. The in-migrant division then becomes, in turn, another source of potential entrepreneurs. Community factors play a contributory role in the overall development process, particularly during the second phase. The presence of a local university is an amenity that acts to attract and retain technical workers. Many corporations consider the presence of a university as one of their major location criteria for a technical division. Cultural amenities such as theater, music, entertainment, play a similar role to that of a university. Local facilities for education are highly important as a family attraction. All of a community's special attractions tend to create a community with an intellectual profile that tends to attract technical entrepreneurs and the key manpower resources they must collect around themselves.

Areas that have a high tourist attraction value (i.e., the "sunshine" states, coastal resorts, etc.) have an advantage in attracting and retaining potential entrepreneurs, technical professionals, and corporate divisions from other areas. Familiarity with an area resulting from many years of attracting tourists provides a "pull" on all kinds of industries, particularly on the "footloose" industries--those not tied to local natural resources or transportation services. High-technology companies are in the footloose category. The primary resource in a technical activity is the technical professional workforce. Given the attractive community as a location, the company experiences less trouble in bringing the necessary resources to the location.

The third phase -- sustained growth

The number of technical companies accumulates in an area and a point is reached in which the technical-company-formation process begins to sustain itself. The number of technical-company-formations rises from one a year to two and more a year. Services formerly maintained as marginal operations within the companies are now spun-off to provide efficient services to a community of companies. The more companies in the community, the greater the number of sources for potential spin off and an increase in the formation rate.

The time required to reach the third phase and the strength of its thrust is dependent on the way the earlier phases of technical-company formation in a community have developed. The greater the variety of technical companies in the community, the greater the apparent strength of the third phase. When a community develops as a technical industrial area clustered around a single specialty, the development is more limited. A single specialty area may create more jobs than other areas, but it is less resilient to shifts and variations in the marketplace.

Making it happen

Can entrepreneurship be deliberately made to happen in a community? What can we affect in the process of eliciting and developing and even attracting entrepreneurial behavior in a community? What can be done to generate the entrepreneurial events that might be a key to the development of a self-sustaining, developmental process in a community and in a region?

The kinds of programs that might be undertaken to develop and bring entrepreneurship to bear on development at the less-than-national level are suggested by the data described above. Some of the elements that might be included in such programs include the following:

(1) Actions to attract small and diverse companies to a region. New companies form more readily from small companies rather than large companies. Lesser developed area expend great efforts to attract large companies that deal with them on almost equal terms while ignoring smaller firms with the experiences that are most relevant to the scale of operations in a developing area. Furthermore, smaller firms gain real advantage from small concessions, while larger firms must be given very large concessions. Smaller companies also generate entrepreneurs; as Cooper has shown, small corporate divisions are incubator organizations.

(2) Programs to generate new company formation. It is possible to provide potential entrepreneurs with experiences that will make the company-forming act more credible to them. Not included here are the many courses on business management that help the committed entrepreneur, but are not too effective in making the individual feel that the act is credible. Of course, supplying the needed resources helps.

(3) Programs to provide the industrial 'ecology' that will enable new companies to form and survive. This can include: (a) Programs for educating the financial community in the risks and characteristics of new, small companies and in the requirements of different industries, (b) the development and fielding of substitutes for the various factors and services only available in very large, well established communities. An example of the latter could be governmental support for a network of excellent manufacturers' representatives as a substitute for the market opportunities of a larger community, (c) special efforts to attract the kinds of support services to a community that make company startup less costly and company survival easier to achieve; machine shops, plating services, blueprinting, etc., (d) transportation support is very useful in this regard, and

communities have much experience in this sector, (e) incubator industrial facilities with low rentals and various services on an as-needed basis.

Interaction between the four elements in the company-formation process

Being overdetermined, the company-formation process cannot be attributed to one of the elements by itself. For example, during a depression or recession there is a large amount of displacement of individuals who have been laid off from their jobs, an event that would tend to raise the number of new company formations. However, simultaneously, the recession lowers the amount of available resources thus constraining the formation rate. Though the Dun and Bradstreet incorporations are highly contaminated with all kinds of company changes in status and only represent about half of the U.S. inventory of companies, one can get some notion of the surge in company formations by examining it in terms of its own trends. During the recent economic recession there was a slight plateauing in the company-formation rates rather than a cutback--that is a plateauing of a constantly rising curve.

Another example of the interchange between the elements of the process is the tradeoff between the psychological measure of I-E (Internal-External locus-of-control) and credibility of the company-formation act. In the company-formation studies by Shapero and his colleagues (Shapero, 1975, Shapero et al., 1973), entrepreneurs were found who were very external in terms of the I-E Scale, but who came from a family with a very independent father as a credible example, thus overcoming the lack of internality on the part of the company former. If everyone in the nascent entrepreneur's family had formed a company, how internal would he have to be to be undertake the act?

Though it has not been measured, the observation was made that some people are far more easily displaced than others. Two men undergoing the same work experiences perceive them with somewhat different strengths of response. Thus, one individual might quit on hearing of an impending divisional move, being displaced, while another individual in the same company might reluctantly move, the act not having the same salience to both men. Consequently, the individual with many credible examples of company formations in his family and among his colleagues may be more easily displaced than someone with almost no examples.

Suggested Research Programs

A set of research programs relevant to entrepreneurship and economic development is outlined below for consideration by EDA for inclusion in its research efforts. The overall purpose of the suggested programs is the development of a body of knowledge, techniques and data useful to EDA and other interested organizations in their efforts to develop entrepreneurship as part of their economic development efforts at the less-than-national level.

The suggested research programs have been developed in terms of the following:

-- The company formation aspects of entrepreneurship; other aspects of entrepreneurship such as industrial management are not included.

-- The conceptualization of the company formation process that has been described in this paper.

-- A conscious delineation between the formation and initial survival of new companies and the broader, more inclusive, traditional research interest in 'small business' that concerns the Small Business Administration.

-- An action orientation rather than a theory-building orientation; the suggested research programs are framed with a view to translation of knowledge into workable action programs.

The suggested research programs are meant to be exemplar rather than complete or exhaustive. The intention, here, is to provide a 'sampler' of the kinds of research studies that ~~would be useful and feasible in support of active efforts to elicit and aid the formation and survival of new companies for local economic development.~~ The programs are organized into four general categories under which are listed suggested study areas. The four general categories are the following:

-- The national environment and the company-formation process

-- New companies and local economic development

-- The company-formation process

-- Action experiments

The national environment and the company-formation process. Events and actions at the national level have an important influence on conditions and actions at the local level. An understanding of the effects of national factors on the company-formation process is necessary to the intelligent development of programs for eliciting company formations and for alleviating barriers to company formations. Thus studies of the relationship between national economic conditions, federal legislation and actions and regional differences on company formations are needed to fill important gaps in our current knowledge. Some important areas of study include the following:

(1) Studies of the effects of major economic variables on company-formation and failure rates, nationally, regionally and by industrial sector. Little is known about how company-formation rates are influenced by any of the many economic variables that are identified and measured nationally.

(2) Development of various statistical time series concerning company formations and failures. Present statistics are completely inadequate for purposes of understanding the company-formation and failure process. Dun and Bradstreet data that are presently utilized are not complete and are inadequate for developing an understanding of the company-formation and failure process. We need to develop a variety of statistical bases relevant to the company-formation and failure process, including national, regional, local, economic sectoral formation and failure data.

(3) Studies of regional differences in company-formation and failure rates; particularly with a view to a better understanding of the cultural and social variations in company formations by population subsections, and with a view to gaining an understanding of the effects of differences in regional economic structure on entrepreneurship.

(4) Studies of the effects of federal legislation, taxation and regulation on the formation and survival of new companies.

(5) Studies of the effects of different state and local legislation, taxation, and regulation efforts on the formation and survival of new companies; similar to the studies that have been made of various means for attracting companies to a community.

(6) Studies of the possibilities of new company entry by industry and region with a view to determining which kinds of industrial sectors are most desirable and feasible from a local development viewpoint.

New companies and local economic development. As of now, the specific ways in which new companies enter into and affect their local communities can only be extrapolated from an occasional case study or guessed at from the available models of urban or regional development. In order to understand and be able to intelligently manage the process of local development through the use of new company formations, it is necessary to gain a far more systematic view of the specifics of how new companies take their place in and influence the local economy. Some needed studies are included among the following:

(1) Studies of the new company and innovation to learn:

-- The extent to which new companies are responsible for and effective in the introduction and utilization of innovations, nationally, regionally and locally.

-- The kinds of innovations, if any, that appear to be most amenable to development and diffusion through the new company-formation process.

-- The ways in which new companies and established companies relate in the development and diffusion of innovations.

-- The effects of innovation on the survival of new companies.

(2) Studies of the role of the new company on the development of human resources to find if:

-- New companies develop a cadre of managerial, initiative-taking people who are active contributors to the economic, political and social capabilities of the community.

-- Newly formed companies act to attract professional and skilled people to an area, and if new companies and the kinds of jobs they make available act to retain a community's skilled and professional young people.

-- The role played by new companies in diversifying the human resources of a community.

(3) Studies of the role of company formations in nucleating local industrial complexes including studies of:

-- The formation of particular kinds of technical-industrial complexes, such as those found and already studied in the San Francisco Bay Area and around Boston. We need to know more about the ways in which particular complexes start with a view to being able to specify the process.

-- The growth and development of supporting services and industries in a community.

-- The effects of community factors, social and cultural, on the formation of an industrial complex.

(4) Studies of the contribution of the company-formation process to the economic and social diversification of a community.

(5) Studies of rural entrepreneurship. Little is known about entrepreneurship in rural environments, and more should be known if we are to be able to add an entrepreneurial dimension to our plans for development of our rural areas. We need answers to such questions as:

-- Who are the rural entrepreneurs?

-- What kinds of companies are formed and can survive in a rural environment?

-- What kinds of infrastructure are required for the support of entrepreneurship in rural areas?

The company-formation process. Though one conceptualization of the company-formation process has been developed on the basis of inferences drawn from the available data and presented in this paper, much more must be known about the microstructure of the company-formation process if we are to affect the process in useful ways. Using the conceptualization that has been presented, it is suggested that we need the following kinds of studies:

(1) Studies of the various factors that influence initiation of the company-formation process by an individual or group of nascent entrepreneurs, to learn about:

-- The effects of large displacements on the subsequent formation of companies by those affected, particularly by those displaced by such major events as natural disasters (e.g., tornados), industry economic turndowns (e.g., the major cutbacks in the aerospace industry in the early 1970's), technological displacements (e.g., the replacement of vacuum tubes by semiconductors). Studies of the effects of such displacements may enable us to help minimize their effects by magnifying the natural entrepreneurial responses that result from displacements.

-- The combinations of negative and positive factors that result in company formations with a view to classifying and systematizing our understanding of the company-initiation process.

-- The role of unemployment in causing company formations.

(2) Studies of ethnic entrepreneurship; studies of Black, Chicano, Amerind and other minority groups in entrepreneurship, to determine:

-- The entrepreneurial propensities of subgroupings within ethnic groups; too many programs have assumed an aggregated problem when dealing with ethnic groups while several studies in other countries strongly indicate very great differences within each ethnic group (e.g., the Gujeratis among the East Indians in South Africa are the most entrepreneurial).

-- The kinds of incentives and support activities that have been most effective in achieving company formations.

-- The entrepreneurial impacts of various refugee groups in the United States; Hungarians, Cubans, Vietnamese, etc.

(3) Studies of the extent to which the fielding of an invention or innovation affects the initiation of new ventures, and the effects of corporate constraints, such as the rewards for patents, on causing the formation of new companies.

(4) Studies of the psychological aspects of entrepreneurship. Studies to date have been concerned with the personality characteristics of the entrepreneur,[8] and there is now a need for data on other psychological aspects of the company-formation process, such as:

-- The way in which the actual process is affected by the outlook and motivation of the nascent entrepreneur.

-- The way in which group formations occur; the possible effects of the risky shift phenomenon on formations (i.e., the greater willingness of a group as compared to an individual to make a risky decision).

-- The psychological correlates to the survival of a new company. What kinds of entrepreneurs are more likely to survive? What kinds of situations lead to the decision to quit?

-- The variations in entrepreneurship and their psychological concomitants, if any; the part-time entrepreneur, the promoter, etc.

-- The variations in response to displacement; how much displacement is required to move different people to take action?

-- The prediction of entrepreneurial behavior; to date, all of the studies of company founders have been retrospective rather than predictive, and there is a need now for some predictive studies of company formation and of longer term success.

(5) Studies of the woman entrepreneur

(6) Studies of the origins of the credibility of the company-formation act. As the most powerful variable affecting the decision to form a new company, it is important to better understand the way the act of company formation becomes credible to an individual. We need to know more about:

-- The sources of credibility and the ways in which credibility can be induced.

-- The relationship between credibility and education.

-- The relationship between credibility and the availability of resources.

(7) Studies of the financing of company formations and the financing of very young companies. Very little has been done to study the actual financing of new companies. The emphasis to date has been on institutional sources of financing with too little attention paid to the private investor, the major source of such financing outside the entrepreneur himself. We need:

-- To assemble and collate the scattered studies now available on the subject of venture-capital financing of new companies and to analyze the data by industry, by region and by community. Similar efforts are needed for second-round financing.

-- To know more about the microstructure of the venture-capital financing of new companies, to go beyond the simple statistical compilations of the initial sources of capital of new companies that are now available.

-- Working capital availability for new and different (new technologies that are unfamiliar to the bankers) companies.

-- The availability of trade credit to new companies in different industries.

(8) Studies of the tradeoffs between displacement, the psychological makeup of the nascent entrepreneur, credibility and the availabiity of resources.

(9) Studies of the failure of new companies are needed to fill the most glaring gap in our knowledge about new companies. This is a subject beset by rumors, bad data, bad statistics and very little anecdotal information of value. In order to improve the chances of new companies to survive and flourish, there is a need to extend our knowledge concerning such matters as:

-- The factors that enter into the process that leads to the failure of new and young companies, including a categorization of those factors that are amenable to management by economic development agencies

-- The critical incidents that lead to company failure.

-- The role of company failure in social learning by the failed entrepreneurs and the community in which the failure occurred, including the dampening potential of failure, the probability that the failed entrepreneurs will start subsequent companies.

-- Variations in failure by region, industry, legal form of company and other similar variables.

Action experiments. There is a very useful function to be played by a program of action experiments (i.e., demonstration efforts that are 'instrumented' for measurement of results) in entrepreneurship. The translation of knowledge into useful action can be greatly facilitated by use of a social-economic equivalent of the engineering test of new developments or what the English refer to as 'trials.' Too many programs have been fielded on the basis of very plausible ideas that have not been submitted to the far less costly (in both economic and political terms) process of 'trials.' The trial process serves to test the feasibility of a program and it can be an important means for obtaining the feedback of data that will enable the developing organization to improve the program before it is finally fielded. Some examples of action experiments relevant to entrepreneurship and local economic development are the following:

(1) Design of a standby program for the encouragement of company formations following major displacements. Much as the Red Cross has a standby capability for the saving of lives in the event of an emergency, it is possible to preplan efforts that would go into effect when a major displacement occurs due to such events as the closing of a military base, a major cutback in an aerospace contract or a major layoff in a large industrial plant. Such a program could include multiple approaches to the eliciting and encouragement for results (see Shapero et al., 1971, in which three such action experiments were proposed in detail with particular emphasis on the attraction of unemployed aerospace workers to the areas from which they had originally emigrated).

(2) Design and test of a 'return home' program in which skilled and professional emigrants from an area are encouraged to return home to start new companies.

(3) Design and test of university related programs to field new technology through the spin-off of companies.

(4) Design and test of a series of ethnic entrepreneurship programs that make use of the available data rather than well-motivated by non-data-based ideas, including efforts to make the company-formation act credible to those subsections of an ethnic group that are most likely to respond successfully.

(5) Design and test of a series of experiments aimed at spinning off government and industrial scientists and engineers with 'pieces' of technology that have already been invested in by the government through its many R&D programs for mission-oriented agencies.

(6) Development and test of a program to orient key sources of funds to support company formations.

NOTES

[1] In a report on a survey of state planning for economic development which Hartley completed for the Economic Development Administration (EDA) in 1976, he stated:

> There is no accepted single definition of economic development that is used by all the states. The closest is "more jobs and higher income," which in its simplicity appears easy to measure, but which in reality is quite complex because no state government controls its own economic destiny.
>
> Any number of other goals of economic development activities are often cited by states:
>
> a. Economic growth as a net addition to wealth in the sense of adding to some sort of state gross produce--more jobs and income.
>
> b. Economic growth policy as a "clearly articulated political commitment to determine the rates of change of selected economic indicators.
>
> c. Stabilization--reducing the amplitude of cyclical variations in the state and regional economies.
>
> d. Diversification--reducing the state's dependence on a single industry, such as agriculture, by attempting to develop other sources of employment.
>
> e. Fiscal stability--developing an economic base and maintaining economic growth in the private sector (or in wealth-producing governmental activities) sufficient to support the need for tax revenues.
>
> f. Balanced growth--assuring that all parts of the state acquire appropriate economic growth, most particularly areas of high unemployment and underemployment, both rural and innercity.
>
> g. Equity and distribution--reducing the disparity between income of the lowest percentile of residents (whether Black, Chicano, Indians, migrant farm workers or some other socio-economic grouping) and the higher percentiles.
>
> h. Efficiency--assessing the impact of governmental activities in terms of some sort of quality of life measurements, especially relating to social and environmental perspectives.
>
> i. Providing a "business climate" that is conducive to the efforts of the private sector to provide jobs and make investments (Hartley, 1976).

[2] The Irish potato famine of 1845 was a dramatic, historic lesson in the consequences of a country's vulnerability to lack of diversity through its dependence on a single food crop. The ecologists state that diversity is necessary for the stability and survival of a species; the larger the population and the fewer the food sources, the more vulnerable the population. From the cyberneticians' perspective we have Ashby's Law of Requisite Variety, " . . . for effective regulation in any system, the variety in the control device must be at least equal to that of the disturbances" (Ashby, 1956). The greater the variety in the system, the more unknowns it can cope with.

[3] In another context, the author of this report has suggested use of the concept "the entrepreneurial event' in delineating entrepreneurship from other functions. It is a concept that is more inclusive than company formation,

> I have coined the expression "entrepreneurial event" as a means of identifying the many kinds of venturesome creations that most of us intuitively identify as being entrepreneurial even though they do not fit in with classical definitions of entrepreneurship or cannot identify with some distinct, individual entrepreneur. I define the entrepreneurial event as being the result of the initiative-taking action of an individual or group in which resources are brought together or reorganized into some organizational entity, that is relatively independent in disposing of its resources and returns and that has the opportunity to fail. Thus, a community theater group, a wholly owned subsidiary, and a new, independent government organization can all be considered to be entrepreneurial events (Shapero, 1975).

[4] The manager of the large enterprise is denationalized and becomes a participant in an international culture of managerhood. Place and local custom are artifacts to the manager of a large corporate division. He does not relate to the local scene except outside the dictates of his organization. The local scene is something to be coped with, and, if he is lucky and competent, tomorrow he will be promoted to another local scene and another until he escapes all local scenes by going to headquarters.

[5] There are no really acceptable statistics as to the actual entry and exit rates of companies into and out of the inventory of United States companies. Using IRS data the United States Senate Select Committee on Small Business reported, " . . . In the three-year interval following 1967, the net gain for included industry divisions amounted to 549,000 firms" (U.S. Senate, 1974). Considering the number of companies that exit in a single year, we can assume a minimum of 300,000 formations a year. A telephone conversation with the head of Dun and Bradstreet's research function ended in a mutual estimate that we have on the order of 600,00 to 700,000 new company formations year.

[6] The Levenson instrument gives recognition to the multidimensionality of locus-of-control and consists of 3 scales: Internal (I) which measures the extent to which a person believes he has control over his own life; Powerful Others (P), the extent to which one believes powerful others have cotrol over his life; and Chance (C), the extent to which someone believes luck, chance, or fate controls his life. borland also administered Lynn's Achievement Motivation Questionnaire in order to examine the relationship of a measure of need for achievement (nAch) with intentions to start a company and the measure's interaction with locus-of-control.

[7] Technical companies included those within 16 of the four-digit SIC categories, such as instruments, aircraft, etc.

[8] This has been a much explored area and is included for completeness though the author believes that there is less potential payout here than in other areas of study at this time.